State of California
The Resources Agency
Department of Water Resources

PROJECT EFFECTS ON GROUNDWATER

—

STUDY PLAN W5, TASK 1, DRAFT REPORT

Oroville Facilities Relicensing
FERC Project No. 2100

MARCH 2004

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REPORT SUMMARY

This study was undertaken to determine effects that the Thermalito Forebay and Afterbay may have upon local groundwater level and quality. Initially, all groundwater level and quality data available were collected to determine whether local groundwater is being affected by the surface water features. Task 1, Phase 1 was a review of this existing data. Results obtained in Task 1, Phase 1 from the wells previously monitored in the vicinity of the Thermalito Forebay and Afterbay clearly indicated the effects of the project on groundwater levels. However, since groundwater levels have not been identified as a concern and extensive groundwater level monitoring is already being conducted in the area by DWR and Butte County, no additional groundwater level monitoring was proposed.

However, due to the paucity of data in the project area and local concern for groundwater quality, additional monitoring was proposed to evaluate effects from the project on groundwater quality in Task 1, Phase 2. Surface water quality from the Thermalito Forebay and Afterbay and Feather River were reviewed to identify any constituents that may be elevated and hence could result in degradation of groundwater quality. Organic constituents have not been reported from the surface waters at concentrations greater than the minimum detection levels. Aluminum and mercury were the only metal constituents found in the surface waters that exceed water quality criteria. Nutrients have been found in the surface waters at very low levels and are less than those found in area groundwater. Surface water minerals, particularly calcium, magnesium, chloride, and hardness, are present in surface waters at concentrations that are significantly less than those found previously in area groundwater. Therefore, monitoring was conducted using several metals, minerals, and field parameters to determine effects to local groundwater from surface water features of the project.

Results from Phase 1 and 2 of this study do not indicate any adverse effects to groundwater levels or quality from the Thermalito Forebay or Afterbay. If there are any subtle effects to groundwater from the project facilities, the effects would be beneficial since groundwater levels would be recharged from project facilities and the high mineral content of the groundwater would be diluted with surface water containing much lower mineral levels, resulting in better suitability for all beneficial uses

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1.0 INTRODUCTION

Relicensing participants raised concerns about the effects of project features and operations on groundwater levels and quality downstream from project facilities. Included in the concerns were project-related effects to hyporheic zones along the Feather River. The “hyporheic zone” comprises the interstices or spaces in the mixture of coarse sand, gravel, and other rocks beneath and beside a river or stream. The spaces are permeated by flowing water in contact with that in the stream, and are inhabited by a variety of insects and other aquatic organisms, including fish fry.

Existing and future operation of the Oroville Facilities may have effects on the physical, chemical, and biological components of groundwater quality in the project area. Some physical, chemical, and biological data have been collected from groundwater in the project area. However, these data are not, nor were they expected to be, sufficient to determine compliance with Basin Plan criteria, goals, and objectives (CVRWQCB 2003) established for protection of groundwater beneficial uses. Additional physical, chemical, and biological data were needed to demonstrate project compliance with Basin Plan standards for groundwater.

Oroville Dam and Lake Oroville are underlain by relatively impermeable Mesozoic-era igneous and metamorphic bedrock, which should eliminate any groundwater effects from Lake Oroville. Downstream from the dam, the Feather River and the Thermalito Forebay and Afterbay project features are on much younger and more permeable volcaniclastic and consolidated alluvial sediments, where groundwater recharge occurs. Due to the porosity of the underlying deposits, the hydraulic heads of the Thermalito Forebay and Afterbay surface water features, as well as varied project-related releases to the Feather River, probably contribute to locally higher groundwater levels, though the extent of this effect has not been quantified. It is possible also that groundwater quality locally reflects the characteristics of the water within these project features. To the west of the uplands upon which the Thermalito project features are situated are the younger alluvial deposits of the Sacramento Valley. At least two aquifer systems have been identified in the valley system. How all three systems interact is not known.

A study plan was developed and approved by the Environmental Workgroup to evaluate the effects from project facilities and operations on groundwater levels and quality (Task 1) and hyporheic connectivity of the Feather River and Oroville Wildlife Area ponds (Task 2). This report presents results from the groundwater investigation.

1.1 BACKGROUND INFORMATION

1.1.1 Statutory/Regulatory Requirements

Demonstration of compliance with basin plan objectives is necessary for the SWRCB to issue a water quality certification. Basin plan objectives for both surface and groundwater include provisions that prohibit chemical constituents in concentrations that adversely affect beneficial uses, create tastes and odors, or produce detrimental effects in human, plant, animal, or aquatic life. The water quality certification is needed for license renewal with the Federal Energy Regulatory Commission.

1.1.2 Study Area

The study includes areas where groundwater was anticipated to be affected by project features as well as reference sites upgradient from potential project effects. The study area for Task 1 includes areas adjacent to the west and south of the Thermalito Forebay and Afterbay, while the study area for Task 2 includes the Feather River in the vicinity of the Oroville Wildlife Area and ponds in this area.

1.2 DESCRIPTION OF FACILITIES

The Oroville Facilities were developed as part of the State Water Project, a water storage and delivery system of reservoirs, aqueducts, power plants, and pumping plants. The main purpose of the SWP is to store and distribute water to supplement the needs of urban and agricultural water users in northern California, the San Francisco Bay area, the San Joaquin Valley, and southern California. The Oroville Facilities are also operated for flood management, power generation, to improve water quality in the Delta, provide recreation, and enhance fish and wildlife.

FERC Project No. 2100 encompasses 41,100 acres and includes Oroville Dam and Reservoir, three power plants (Hyatt Pumping-Generating Plant, Thermalito Diversion Dam Power Plant, and Thermalito Pumping-Generating Plant), Thermalito Diversion Dam, the Feather River Fish Hatchery and Fish Barrier Dam, Thermalito Power Canal, Oroville Wildlife Area, Thermalito Forebay and Forebay Dam, Thermalito Afterbay and Afterbay Dam, and transmission lines, as well as a number of recreational facilities. An overview of these facilities is provided on Figure 1.2-1. The Oroville Dam, along with two small saddle dams, impounds Lake Oroville, a 3.5-million-acre-feet capacity storage reservoir with a surface area of 15,810 acres at its normal maximum operating level.

The hydroelectric facilities have a combined licensed generating capacity of approximately 762 megawatts. The Hyatt Pumping-Generating Plant is the largest of the three power plants with a capacity of 645 MW. Water from the six-unit underground power plant (three conventional generating and three pumping-generating units) is discharged through two tunnels into the Feather River just downstream of Oroville Dam. The plant has a generating and pumping flow capacity of 16,950 cfs and 5,610 cfs, respectively. Other generation facilities include the 3-MW Thermalito Diversion Dam Power Plant and the 114-MW Thermalito Pumping-Generating Plant.

Thermalito Diversion Dam, four miles downstream of the Oroville Dam creates a tail water pool for the Hyatt Pumping-Generating Plant and is used to divert water to the

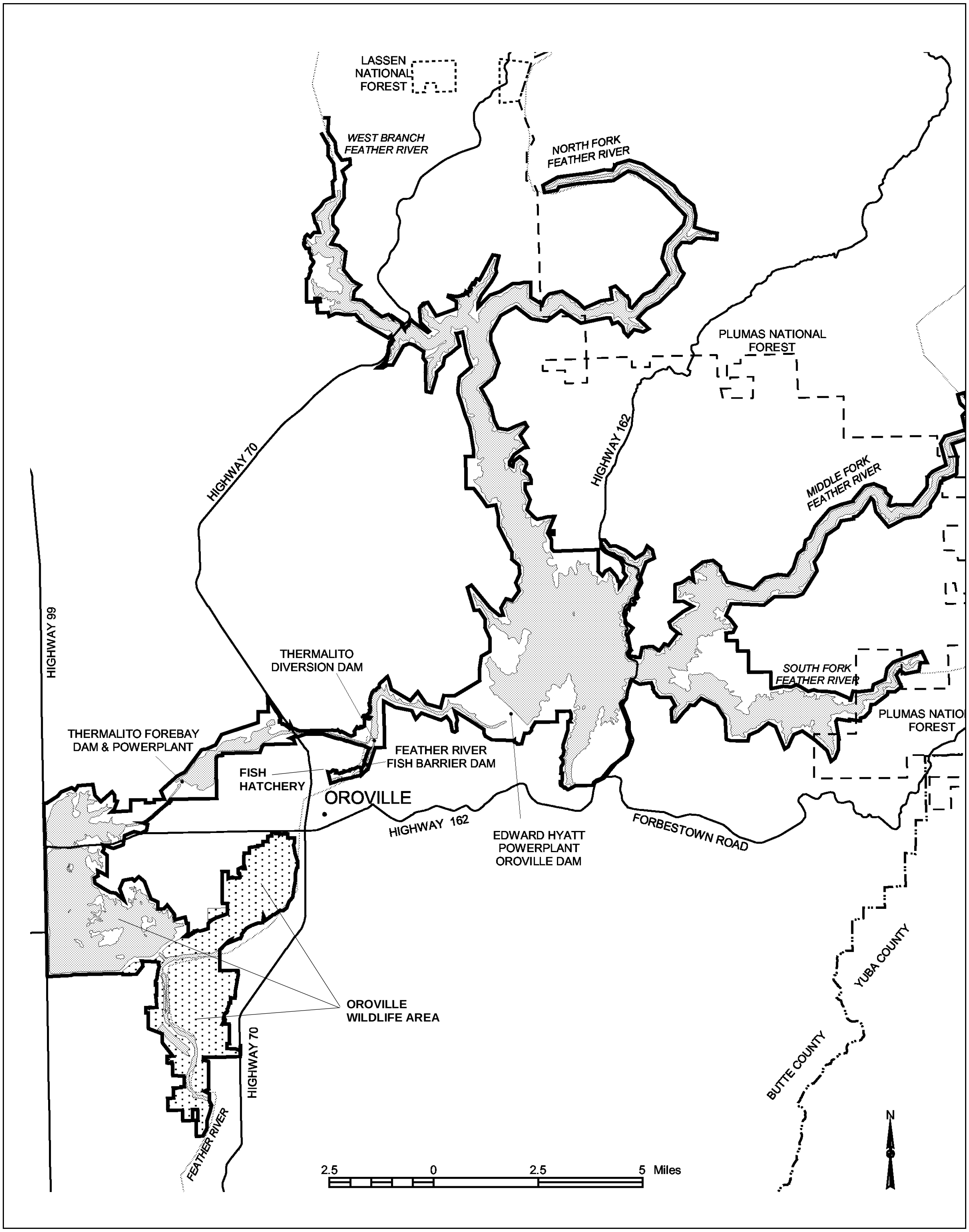

Figure 1.2-1. Oroville Facilities FERC Project Boundary

Thermalito Power Canal. The Thermalito Diversion Dam Power Plant is a 3-MW power plant located on the left abutment of the Diversion Dam. The power plant releases a maximum of 615 cfs of water into the river.

The Power Canal is a 10,000-foot-long channel designed to convey generating flows of 16,900 cfs to the Thermalito Forebay and pump-back flows to the Hyatt Pumping-Generating Plant. The Thermalito Forebay is an off-stream regulating reservoir for the 114-MW Thermalito Pumping-Generating Plant. The Thermalito Pumping-Generating Plant is designed to operate in tandem with the Hyatt Pumping-Generating Plant and has generating and pump-back flow capacities of 17,400 cfs and 9,120 cfs, respectively. When in generating mode, the Thermalito Pumping-Generating Plant discharges into the Thermalito Afterbay, which is contained by a 42,000-foot-long earth-fill dam. The Afterbay is used to release water into the Feather River downstream of the Oroville Facilities, helps regulate the power system, provides storage for pump-back operations, and provides recreational opportunities. Several local irrigation districts receive water from the Afterbay.

The Feather River Fish Barrier Dam is downstream of the Thermalito Diversion Dam and immediately upstream of the Feather River Fish Hatchery. The flow over the dam maintains fish habitat in the low-flow channel of the Feather River between the dam and the Afterbay outlet, and provides attraction flow for the hatchery. The hatchery was intended to compensate for spawning grounds lost to returning salmon and steelhead trout from the construction of Oroville Dam. The hatchery can accommodate 15,000 to 20,000 adult fish annually.

The Oroville Facilities support a wide variety of recreational opportunities. They include: boating (several types), fishing (several types), fully developed and primitive camping (including boat-in and floating sites), picnicking, swimming, horseback riding, hiking, off-road bicycle riding, wildlife watching, hunting, and visitor information sites with cultural and informational displays about the developed facilities and the natural environment. There are major recreation facilities at Loafer Creek, Bidwell Canyon, the Spillway, North and South Thermalito Forebay, and Lime Saddle. Lake Oroville has two full-service marinas, five car-top boat launch ramps, ten floating campsites, and seven dispersed floating toilets. There are also recreation facilities at the Visitor Center and the OWA.

The OWA comprises approximately 11,000 acres west of Oroville that is managed for wildlife habitat and recreational activities. It includes the Thermalito Afterbay and surrounding lands (approximately 6,000 acres) along with 5,000 acres adjoining the Feather River. The 5,000 acre area straddles 12 miles of the Feather River, which includes willow and cottonwood lined ponds, islands, and channels. Recreation areas include dispersed recreation (hunting, fishing, and bird watching), plus recreation at developed sites, including Monument Hill day use area, model airplane grounds, three boat launches on the Afterbay and two on the river, and two primitive camping areas.

California Department of Fish and Game's habitat enhancement program includes a wood duck nest-box program and dry land farming for nesting cover and improved wildlife forage. Limited gravel extraction also occurs in a number of locations.

1.3 CURRENT OPERATIONAL CONSTRAINTS

Operation of the Oroville Facilities varies seasonally, weekly and hourly, depending on hydrology and the objectives DWR is trying to meet. Typically, releases to the Feather River are managed to conserve water while meeting a variety of water delivery requirements, including flow, temperature, fisheries, recreation, diversion and water quality. Lake Oroville stores winter and spring runoff for release to the Feather River as necessary for project purposes. Meeting the water supply objectives of the SWP has always been the primary consideration for determining Oroville Facilities operation (within the regulatory constraints specified for flood control, in-stream fisheries, and downstream uses). Power production is scheduled within the boundaries specified by the water operations criteria noted above. Annual operations planning is conducted for multi-year carry over. The current methodology is to retain half of the Lake Oroville storage above a specific level for subsequent years. Currently, that level has been established at 1,000,000 acre-feet; however, this does not limit draw down of the reservoir below that level. If hydrology is drier than expected or requirements greater than expected, additional water would be released from Lake Oroville. The operations plan is updated regularly to reflect changes in hydrology and downstream operations. Typically, Lake Oroville is filled to its maximum annual level of up to 900 feet above mean sea level in June and then can be lowered as necessary to meet downstream requirements, to its minimum level in December or January. During drier years, the lake may be drawn down more and may not fill to the desired levels the following spring. Project operations are directly constrained by downstream operational constraints and flood management criteria as described below.

1.3.1 Downstream Operation

An August 1983 agreement between DWR and DFG entitled, "Agreement Concerning the Operation of the Oroville Division of the State Water Project for Management of Fish & Wildlife," sets criteria and objectives for flow and temperatures in the low flow channel and the reach of the Feather River between Thermalito Afterbay and Verona. This agreement: (1) establishes minimum flows between Thermalito Afterbay Outlet and Verona which vary by water year type; (2) requires flow changes under 2,500 cfs to be reduced by no more than 200 cfs during any 24-hour period, except for flood management, failures, etc.; (3) requires flow stability during the peak of the fall-run Chinook spawning season; and (4) sets an objective of suitable temperature conditions during the fall months for salmon and during the later spring/summer for shad and striped bass.

1.3.1.1 Instream Flow Requirements

The Oroville Facilities are operated to meet minimum flows in the Lower Feather River as established by the 1983 agreement (see above). The agreement specifies that Oroville Facilities release a minimum of 600 cfs into the Feather River from the Thermalito Diversion Dam for fisheries purposes. This is the total volume of flows from the diversion dam outlet, diversion dam power plant, and the Feather River Fish Hatchery pipeline.

Generally, the instream flow requirements below Thermalito Afterbay are 1,700 cfs from October through March, and 1,000 cfs from April through September. However, if runoff for the previous April through July period is less than 1,942,000 af (i.e., the 1911-1960 mean unimpaired runoff near Oroville), the minimum flow can be reduced to 1,200 cfs from October to February, and 1,000 cfs for March. A maximum flow of 2,500 cfs is maintained from October 15 through November 30 to prevent spawning in overbank areas that might become de-watered.

1.3.1.2 Temperature Requirements

The Diversion Pool provides the water supply for the Feather River Fish Hatchery. The hatchery objectives are 52 ºF for September, 51 ºF for October and November, 55 ºF for December through March, 51 ºF for April through May 15, 55 ºF for last half of May, 56 ºF for June 1-15, 60 ºF for June 16 through August 15, and 58 ºF for August 16-31. A temperature range of plus or minus 4 ºF is allowed for objectives, April through November.

There are several temperature objectives for the Feather River downstream of the Afterbay Outlet. During the fall months, after September 15, the temperatures must be suitable for fall-run Chinook. From May through August, they must be suitable for shad, striped bass, and other warmwater fish.

The National Marine Fisheries Service has also established an explicit criterion for steelhead trout and spring-run Chinook salmon. Memorialized in a biological opinion on the effects of the Central Valley Project and SWP on Central Valley spring-run Chinook and steelhead as a reasonable and prudent measure; DWR is required to control water temperature at Feather River mile 61.6 (Robinson's Riffle in the low-flow channel) from June 1 through September 30. This measure requires water temperatures less than or equal to 65 ºF on a daily average. The requirement is not intended to preclude pump-back operations at the Oroville Facilities needed to assist the State of California with supplying energy during periods when the California ISO anticipates a Stage 2 or higher alert.

The hatchery and river water temperature objectives sometimes conflict with temperatures desired by agricultural diverters. Under existing agreements, DWR provides water for the Feather River Service Area (FRSA) contractors. The contractors claim a need for warmer water during spring and summer for rice germination and growth (i.e., 65 ºF from approximately April through mid May, and 59 ºF during the remainder of the growing season). There is no obligation for DWR to meet the rice water temperature goals. However, to the extent practical, DWR does use its operational flexibility to accommodate the FRSA contractor's temperature goals.

1.3.1.3 Water Diversions

Monthly irrigation diversions of up to 190,000 (July 2002) af are made from the Thermalito Complex during the May through August irrigation season. Total annual entitlement of the Butte and Sutter County agricultural users is approximately 1 maf. After meeting these local demands, flows into the lower Feather River continue into the Sacramento River and into the Sacramento-San Joaquin Delta. In the northwestern portion of the Delta, water is pumped into the North Bay Aqueduct. In the south Delta, water is diverted into Clifton Court Forebay where the water is stored until it is pumped into the California Aqueduct.

1.3.1.4 Water Quality

Flows through the Delta are maintained to meet Bay-Delta water quality standards arising from DWR's water rights permits. These standards are designed to meet several water quality objectives such as salinity, Delta outflow, river flows, and export limits. The purpose of these objectives is to attain the highest water quality, which is reasonable, considering all demands being made on the Bay-Delta waters. In particular, they protect a wide range of fish and wildlife including Chinook salmon, Delta smelt, striped bass, and the habitat of estuarine-dependent species.

1.3.2 Flood Management

The Oroville Facilities are an integral component of the flood management system for the Sacramento Valley. During the wintertime, the Oroville Facilities are operated under flood control requirements specified by the U.S. Army Corps of Engineers. Under these requirements, Lake Oroville is operated to maintain up to 750,000 af of storage space to allow for the capture of significant inflows. Flood control releases are based on the release schedule in the flood control diagram or the emergency spillway release diagram prepared by the USACE, whichever requires the greater release. Decisions regarding such releases are made in consultation with the USACE.

The flood control requirements are designed for multiple use of reservoir space. During times when flood management space is not required to accomplish flood management objectives, the reservoir space can be used for storing water. From October through March, the maximum allowable storage limit (point at which specific flood release would have to be made) varies from about 2.8 to 3.2 maf to ensure adequate space in Lake

Oroville to handle flood flows. The actual encroachment demarcation is based on a wetness index, computed from accumulated basin precipitation. This allows higher levels in the reservoir when the prevailing hydrology is dry while maintaining adequate flood protection. When the wetness index is high in the basin (i.e., wetness in the watershed above Lake Oroville), the flood management space required is at its greatest amount to provide the necessary flood protection. From April through June, the maximum allowable storage limit is increased as the flooding potential decreases, which allows capture of the higher spring flows for use later in the year. During September, the maximum allowable storage decreases again to prepare for the next flood season. During flood events, actual storage may encroach into the flood reservation zone to prevent or minimize downstream flooding along the Feather River.

2.0 NEED FOR STUDY

Construction of Oroville Dam, impoundment of water to form Lake Oroville, and associated facilities of the project have affected the physical, chemical, and biological characteristics of water in the Feather River. Since the Feather River provides recharge to local groundwater, these changes in water quality characteristics in the river may subsequently affect groundwater characteristics. In addition, recharge to groundwater from the Thermalito Forebay and Afterbay may affect groundwater quality as well as levels. Ponds in the Oroville Wildlife Area are likely hydraulically connected to the Feather River, and thus may also be affected by the water quality characteristics of the Feather River.

Though the project may potentially affect biological characteristics of groundwater, aquatic macroinvertebrates as a component of the biological characteristics of groundwater are not included for study since sufficient information about these organisms is being obtained from riffle areas of the Feather River in Study Plans SPW1 and SPF1.

Prior to issuance of a new license for the project, the Federal Energy Regulatory Commission (FERC) will require a water quality certification by the State Water Resources Control Board (SWRCB). The certification requires a determination by the SWRCB that the project complies with appropriate requirements of the Central Valley Regional Water Quality Control Board (CVRWQCB) Basin Plan, which includes water quality objectives for protection of designated beneficial uses. The CVRWQCB has established groundwater quality objectives for bacteria, chemical constituents, radioactivity, tastes and odors, and toxicity.

Information obtained from the study will be used to determine project effects to groundwater, demonstrate compliance with water quality standards and other appropriate requirements in the application for water quality certification, and identify the need for project modification or mitigation for impacts to groundwater quality or levels from project operations. Water quality analysis is required for determination of conditions in the water quality certification by the SWRCB.

3.0 STUDY OBJECTIVE(S)

The objectives of this study are to quantify the localized effects on groundwater levels and quality from Thermalito Forebay and Afterbay operations, as well as effects from dam releases to the Feather River on water quality and levels in the Oroville Wildlife Area.

3.1 APPLICATION OF STUDY INFORMATION

Information from the study will be used to determine compliance with basin plan objectives, which is necessary for the SWRCB to issue a water quality certification. The water quality certification is needed for license renewal with the Federal Energy Regulatory Commission. Data from Task 2 of the study will also be used by various agencies, such as the DFG and U.S. Fish and Wildlife Service, to evaluate any project related effects to wildlife species that may prey on aquatic species in waters affected by project releases.

4.0 METHODOLOGY

This study evaluates effects from project features to groundwater and hyporheic interaction of the Feather River with ponds in the Oroville Wildlife Area.

4.1 STUDY DESIGN

The study included two tasks: Task 1 - evaluation of project effects to local groundwater levels and quality, and Task 2 - evaluation of effects of any hydraulic connectivity between the Feather River and Oroville Wildlife Area ponds. This report presents results of the first task. Evaluation of effects to groundwater levels and quality was conducted in phases. The first phase reviewed current groundwater monitoring data to determine whether sufficient data were available to evaluate project effects to groundwater, while the second phase included additional water quality data collection and analyses.

4.1.1 Task 1, Phase 1 — Inventory Existing Wells and Assessment of Existing Groundwater Data and Current Groundwater Monitoring Activities

An inventory of wells was made utilizing records maintained at the California Department of Water Resources office in Red Bluff. Potential impacts to groundwater from the Thermalito project features would likely occur in a shallow, unconfined setting. Therefore, wells were grouped as shallow (100 feet deep or less) or deeper. Data for well location, surface elevation, depth, design, and use were entered into a GIS database. The groundwater level and quality data from the wells was reviewed to determine localized effects on groundwater from the Thermalito Forebay and Afterbay, or whether additional data were needed. Historic groundwater quality data were obtained from the Water Data Information System database and locally maintained data, while surface water quality data were obtained from study results of SPW1. Groundwater and surface water data were compared to identify any effects to groundwater from the project reservoirs.

4.1.2 Task 1, Phase 2 — Groundwater Quality Monitoring

Data evaluation from Task 1, Phase 1 determined that existing groundwater level monitoring data were adequate and that little concern existed for project effects to groundwater levels, but project effects to groundwater quality was still an issue. Therefore, Phase 2 was initiated to implement a groundwater quality monitoring program.

Additional groundwater quality data were collected for Task 1, Phase 2 in the vicinity of both the Thermalito Forebay and Afterbay. The groundwater quality monitoring program included wells currently monitored semi-annually and monthly for groundwater levels and several additional existing shallow wells to enhance areal coverage of the shallow aquifer. Groundwater quality was measured during the spring and fall from the existing monitoring wells and additional wells included in the study. Groundwater samples were analyzed for general mineral composition, aluminum, mercury, and physical parameters, including pH, conductivity, and temperature, at the time of sampling. The general mineral and physical parameter analyses enabled the ionic composition and physical characteristics of the groundwater to be compared with those from the lower depths of the Thermalito Forebay and Afterbay collected in SPW1 to provide an indication of connectivity. Analytical results from the lower depths of the project waters were used to compare to groundwater quality. The water at the interface between the water and the soil at the bottom of the reservoirs is most likely to be influencing groundwater quality.

4.1.2.1 Sampling Sites

Wells in the study area were selected for groundwater quality monitoring from areas upgradient and downgradient of the project facilities to determine if there was any impact upon the groundwater by these facilities and their operations. Only wells with State Well Logs were chosen for monitoring. Well logs provide information on geology, water levels, well depth, perforation intervals, and use.

Not all wells that were monitored for groundwater levels in Phase 1 were sampled for water quality in this study due to owner reluctance to allow access for sample collection. Additionally, no piezometers were sampled as they had been rendered inaccessible in past years by DWR staff for safety reasons. Additional wells were located to augment those currently sampled. Eighteen wells were sampled for this study (Figure 4.1.2.1-1). Completed well depths ranged from 61 to 463 feet, while the casing depths ranged from 36 to 221 feet below the ground surface (Table 4.1.2.1-1). The shallowest level of water came from a perforated zone in one well at 24 to 48 feet below the ground surface.

4.1.2.2 Sampling Method

Water samples were collected in June to July, and again in October to November of 2003. Samples were collected at the well head whenever possible. If samples could not be obtained at the well head, the nearest spigot or other water outlet from the well was sampled. The wells were purged prior to sampling to ensure a fresh water sample. While purging, temperature, conductivity, and pH were monitored at five-minute intervals. When these parameters had three consecutive stable readings, sample collection began.

Field sampling procedures followed DWR's *Sampling Manual for Environmental Measurement Projects* (DWR 1994). Water temperature, conductivity, and pH were measured in the field at each well, although temperature was only recorded if the water sample was collected at the wellhead. Temperature and conductivity were measured

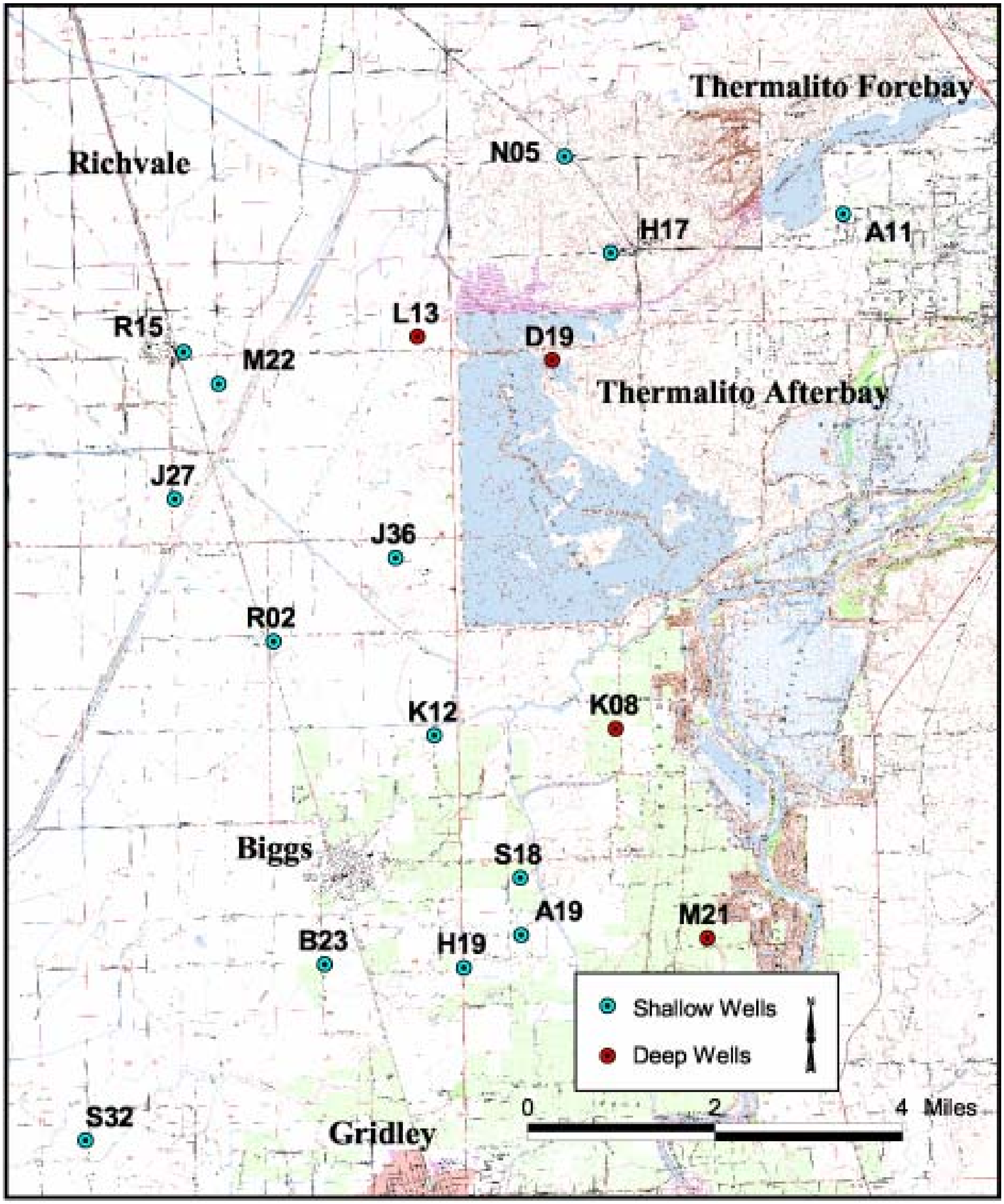

Figure 4.1.2.1-1. Task 1, Phase 2 groundwater quality monitoring wells.

Table 4.1.2.1-1. Groundwater quality monitoring well construction data.

Well	Map Locater	Date Drilled	Total Depth (ft)	Completed Depth (ft)	Casing Depth (ft)	Perforated Depths (ft)	Sealed Depth (ft)
18N02E02M	R02	6/18/70	90	86	52	None	No
18N02E12M	K12	9/21/84	79	79	49	None	N/A
18N02E23M	B23	1/6/58	87	85	48	None	No
18N02E32H01M	S32	7/26/86	115	115	60	None	20
18N03E08B03M	K08	3/26/78	463	463	156	None	N/A
18N03E18M	S18	9/4/87	100	100	60	None	22
18N03E19M	H19	3/12/67	78	75	48	None	No
18N03E19M	A19	4/8/83	90	90	80	None	20
18N03E21G01M	M21	1948	125	None	None	None	N/A
19N02E13Q01M	L13	12/13/01	223	221	221	130-140 200-210	N/A
19N02E15N02M	R15	12/8/63	123	120	36	None	No
19N02E22M	M22	9/14/98	61	61	55	None	20
19N02E27M	J27	8/18/67	100	92	60	None	No
19N02E36M	J36	3/24/68	80	80	80	32-80	No
19N03E05N02M	N05	3/21/61	182	180	48	24-48	No
19N03E11M	A11	9/22/92	93	93	93	53-93	40
19N03E17M	H17	6/19/76	62	62	60	None	20
19N03E19M	D19	3/22/92	100	100	100	None	54

with an Orion Model 128 conductivity/temperature meter. A Hellige comparator was used for pH determination.

Water samples were collected in sample-rinsed polyethylene bottles for physical and chemical analyses. Samples were transported to the DWR Northern District laboratory for conductivity measurements to verify field conductivity results.

Samples for mineral analyses were collected in sample-rinsed polyethylene bottles. Samples for dissolved parameters were filtered through a 0.45 micron pore diameter nitrocellulose membrane filter. The samples were then preserved per standard procedures and submitted to DWR's Bryte Chemical Laboratory in West Sacramento, California. Samples were analyzed according to protocols approved by the U.S. Environmental Protection Agency or American Public Health Association (APHA 1998).

Samples for trace metals analyses were collected in accordance with methods outlined in USEPA Method 1669 (USEPA 1996). Samples were collected for total recoverable aluminum and mercury and dissolved aluminum in laboratory-prepared collection bottles. The bottles for aluminum analyses were provided by DWR's Bryte Chemical

Laboratory, which also performed the analyses. The bottles for mercury analyses were provided by Frontier Geosciences in Seattle, Washington, which performed the mercury analyses.

5.0 STUDY RESULTS

5.1 TASK 1, PHASE 1 – INVENTORY EXISTING WELLS AND ASSESSMENT OF EXISTING GROUNDWATER DATA AND CURRENT GROUNDWATER MONITORING

The existing groundwater infrastructure, groundwater level monitoring data, and groundwater quality monitoring data were evaluated in Phase 1.

5.1.1 Existing Groundwater Infrastructure

About 162 wells (Figure 5.1.1-1) were identified as existing within a two-mile radius downgradient from the Thermalito Afterbay, based on the Northern District DWR well log data base, which may not include all wells existing in the area. However, the available data do indicate the relative density and distribution of wells in the area. The wells were mapped with a GIS application, which places each well data point into a one mile square section location indicated on the water well driller's report. Wells were not field located for this evaluation. There are about 63 irrigation wells, 81 domestic wells, and 18 in an "other" category, which includes monitoring, municipal, and an "unknown" use designations. Wells range in depth from 15 to 745 feet with an average depth of 131 feet. Of the 162 wells, 86 are up to 100 feet in depth and 76 are greater than 100 feet in depth. Groundwater flows in a south-southwest direction in the vicinity of the Thermalito Forebay and Afterbay.

The lithology indicated on water well driller's reports was reviewed to evaluate the aquifer materials encountered in wells in the area. That review shows that there is a high degree of vertical and horizontal variability of aquifer materials. Aquifer zones are not uniform in thickness, nor is there much uniformity in the depth of the different aquifer materials encountered in area wells. Therefore, it is too simplistic to divide the total aquifer system into the initial 0 to 100 and greater than 100 foot zones called for in the study plan. Many well reports indicate that there are at least two water bodies: a confined zone and an unconfined zone. The aquifer system may also include a semi-confined character but the well log data are insufficient on which to base that determination.

The complexity of the areal and depth distribution of aquifer materials is due to the location of the environment in which the sediments forming the aquifers were deposited. The Afterbay was constructed on an older, dissected upland, consisting of coarse gravels cemented in a sandy clay matrix. The upland area is adjacent to the edge of the groundwater basin to the west where younger alluvial materials overlap the older sediments. The younger sediments consist of alluvial fan, stream, and basin deposits. At the toe of the Afterbay is an alluvial fan complex that is criss-crossed by small distributary streams. These streams trend into the basin in a south to south-southwest direction. Trending from east to west are the younger deposits that transition from

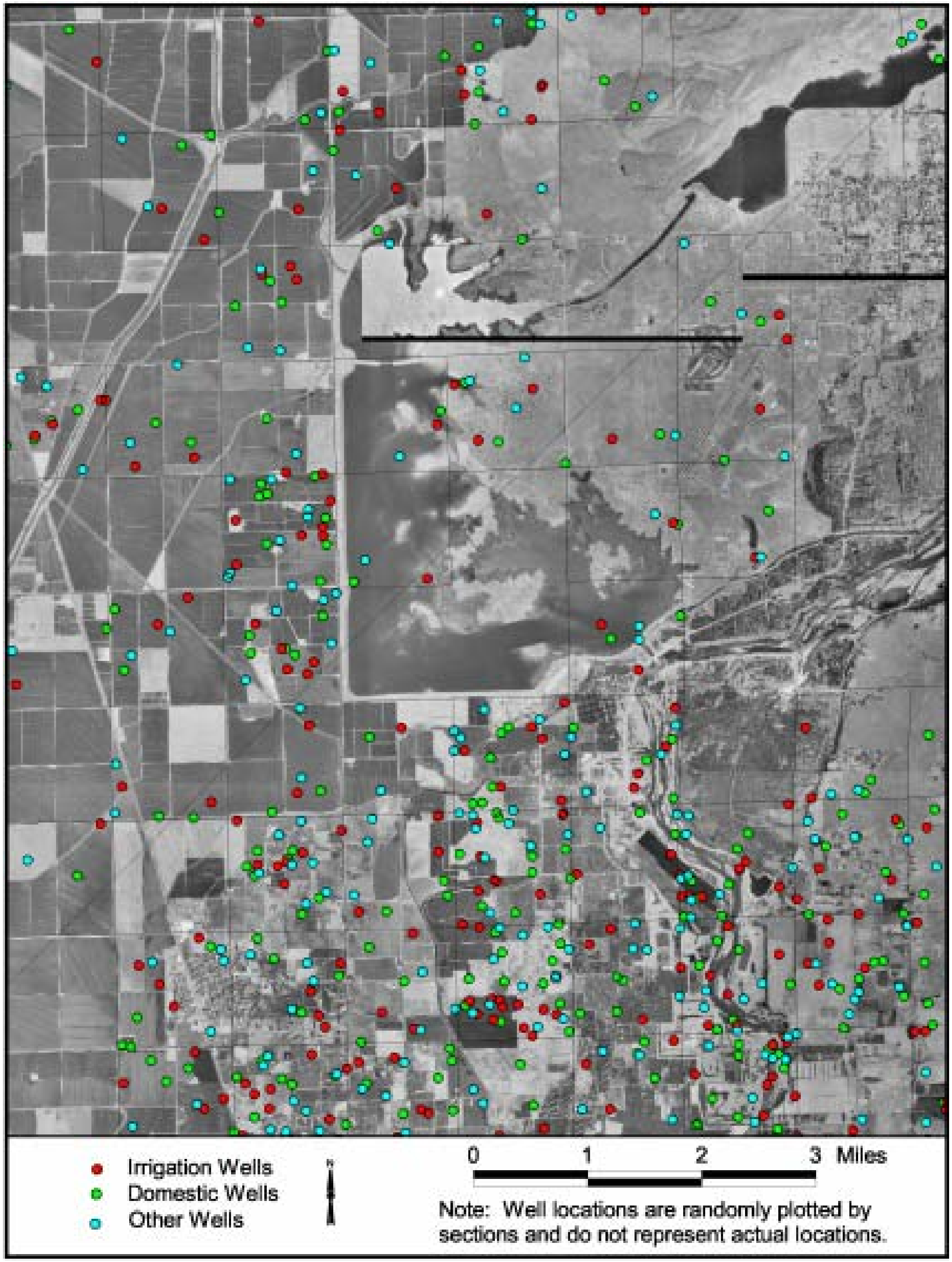

Figure 5.1.1-1. Thermalito Afterbay area groundwater wells.

coarse to fine. In the subsurface, the fine clay materials of the basin deposits interfinger with the coarser sands and gravels of the alluvial fans and stream deposits. The resulting form of the local aquifer system is an irregular wedge of alluvial fan deposits juxtaposed against the older gravels to the east and the younger clays to the west.

5.1.2 Existing Groundwater Level Monitoring

The Northern District's groundwater level monitoring grid in the area adjacent to the Thermalito Forebay and Afterbay was mapped to help evaluate the adequacy of data coverage. There are only thirteen monthly or semi-annual wells currently being monitored for groundwater level in the area (Figure 5.1.2-1). Many of the wells are too far from the project facilities to provide useful information, and large areas have little to no monitoring coverage. Monitoring that would provide information on localized effects to shallow groundwater levels from the Thermalito Afterbay is not currently being conducted.

Two wells potentially affected by the Thermalito Forebay had been monitored for water levels from 1959 to 1982. These wells show that groundwater elevation was increased by about 10 feet following project completion in 1969 (Figure 5.1.2-2).

A monitoring program was developed by DWR after completion of the Oroville Facilities to evaluate water levels and pore pressures in the embankment impounding the Afterbay. A series of piezometers was placed along or near the Afterbay embankment and are monitored on a weekly, bi-weekly, or monthly basis. However, the data from these piezometers are not appropriate to use in determining area groundwater levels since the data may merely indicate leakage from the Afterbay rather than area groundwater levels. In addition, back-pumping at the Afterbay affect the data from these piezometers.

Northern District staff made several attempts to field locate the numerous piezometers to the west and southwest of the Afterbay originally used to evaluate seepage from the Afterbay following construction but since abandoned by DWR. Twelve of these piezometers were located and have been added to the Northern District monthly monitoring grid. These piezometers will provide data on groundwater levels near a portion of the Afterbay.

Butte County has an extensive groundwater level monitoring network (Ed Craddock, Butte County Department of Water and Resource Conservation, pers. comm.). With about 80 wells in the network, there is little concern at the local level for additional groundwater level data.

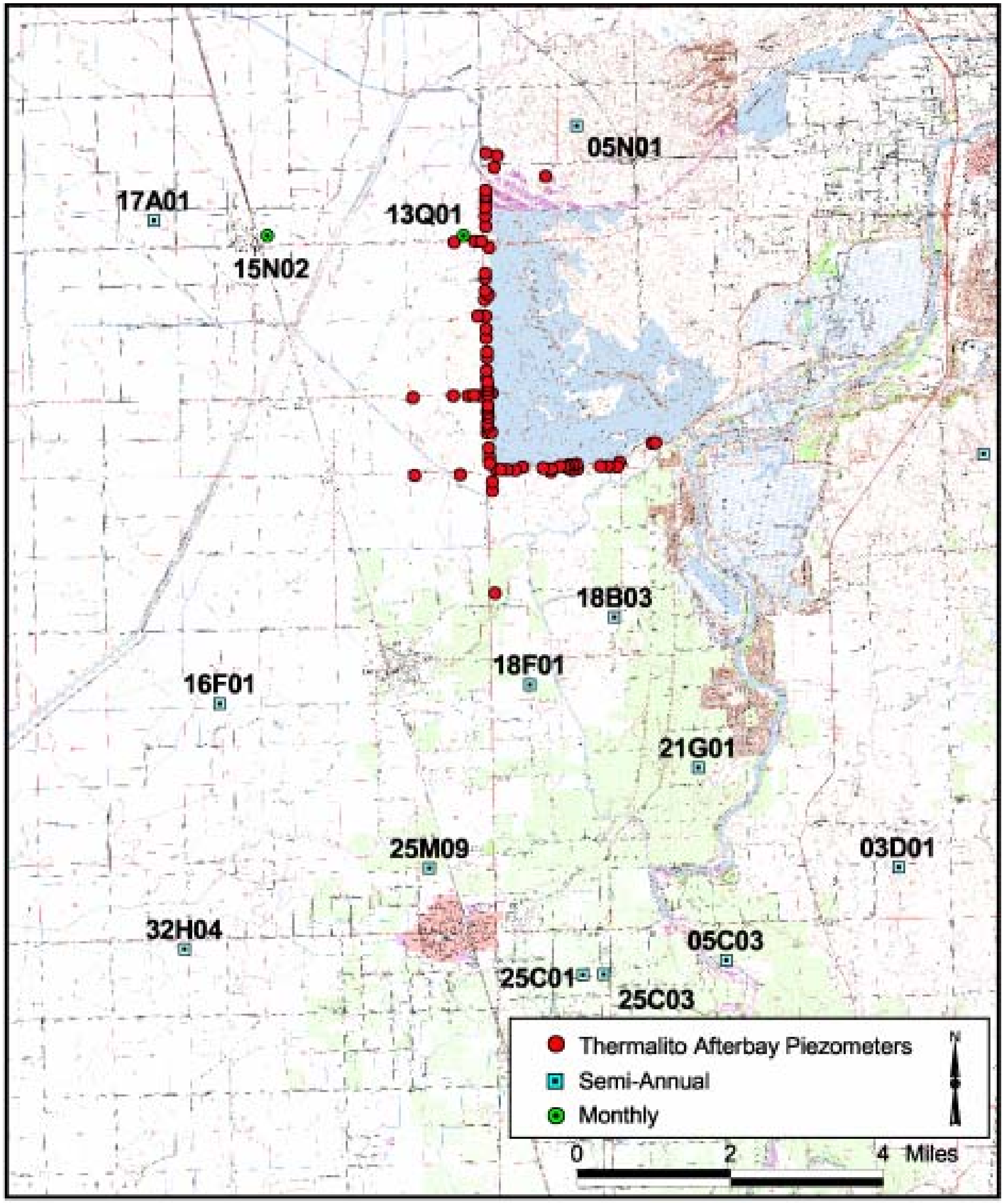

Figure 5.1.2-1. Current DWR groundwater level monitoring wells.

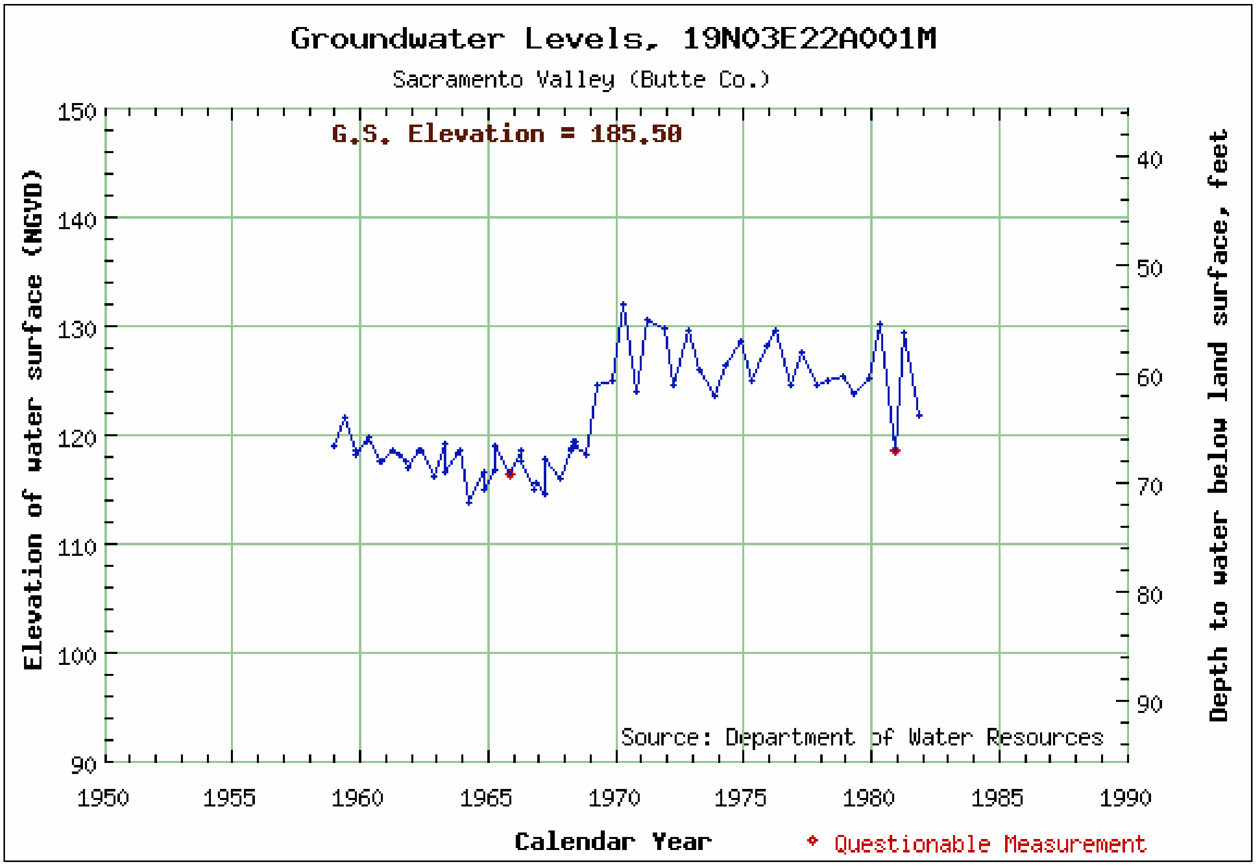

Figure 5.1.2-2 Groundwater levels in the vicinity of the Thermalito Forebay.

5.1.3 Existing Groundwater Quality Monitoring

Thirteen wells have been monitored for water quality in the area (Figure 5.1.3-1). However, since groundwater in the area moves in a south-southwesterly direction, the project has the potential to affect only two of the wells that have been previously monitored within a mile of the project. Available water quality data are very limited for these two wells, as well as others in the area. Nutrients and metals data are only available from one of the wells (12G01). Minerals have been sampled only once from well 24A01, but several times both prior to and following project construction from well 12G01. Pre- and post-project mineral data from this well are similar, though nitrate levels may be somewhat higher in data collected since project completion. Similarly, physical data have been collected only once from well 24A01, but both prior to and subsequent to project construction from well 12G01. Conductivity was generally less in this well prior to project completion, but also ranged in pre-project samples to as high as levels found in post-project samples.

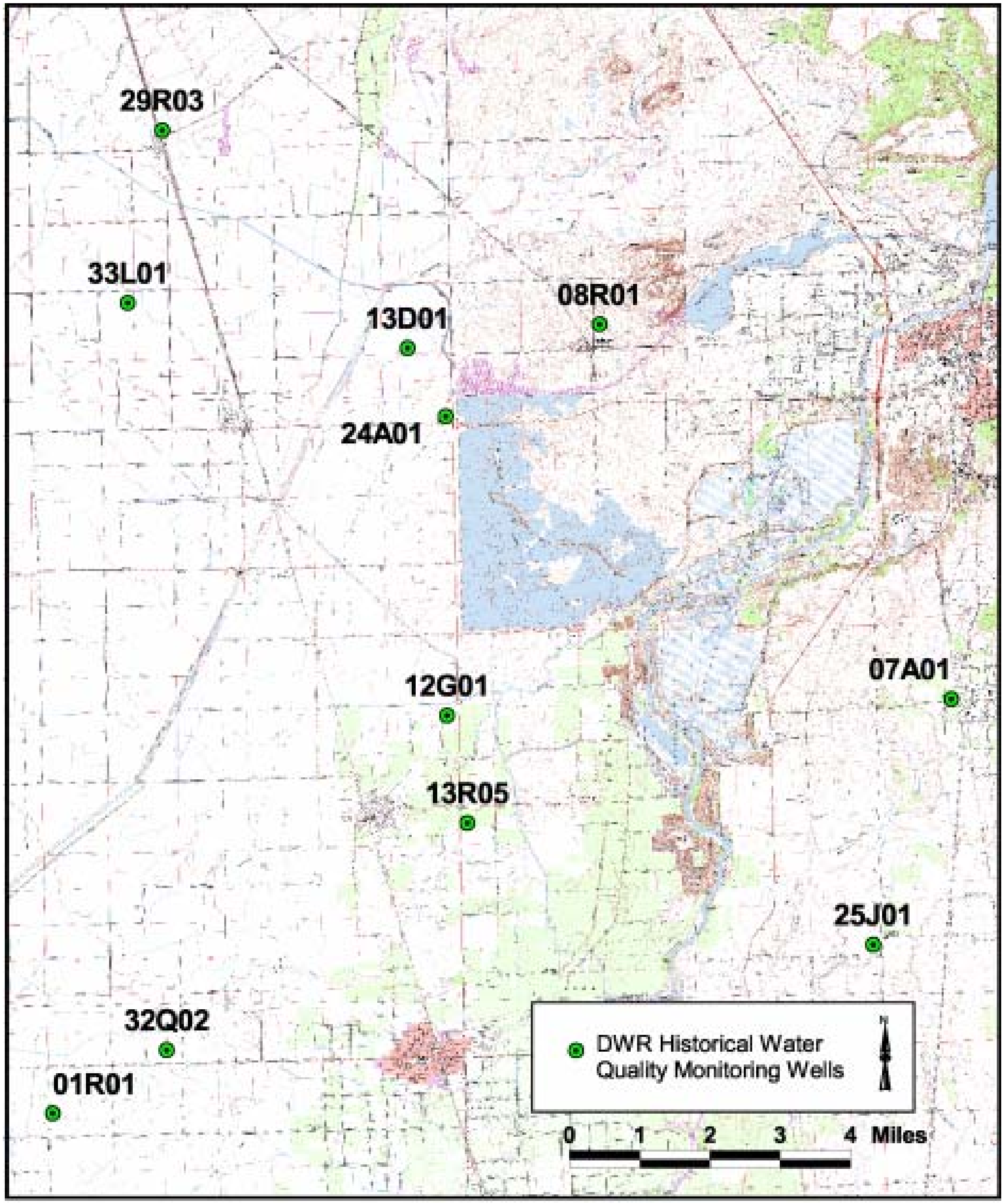

Figure 5.1.3-1. DWR historical groundwater quality monitoring wells.

Minerals were present at much greater levels in the only sample collected from well 24A01 than from samples collected from the Afterbay. Minerals in well 12G01, with the exception of potassium, were also present at much greater levels than from the Afterbay, but, with the exception of sulfate and chloride, were at lower levels than found in well 24A01. Analyses for other constituents (nutrients, metals) are too few for comparison.

Well 24A01 is adjacent to the Afterbay, but the depth and construction are not known. Well 12G01 is over a mile away, which, lacking data from other wells closer to the Afterbay, makes use of this well questionable to determine any effects from the project. The paucity of data from only two wells, for which construction of one is unknown and the other is over a mile from the project, makes meaningful determinations about project effects on groundwater quality impossible to ascertain.

Though groundwater level data indicate that the project has had a significant effect on water elevations in the vicinity of the Thermalito Forebay, no water quality data are available to determine effects to local groundwater quality from the project. An accurate determination of project effects on groundwater quality cannot reliably be made due to the paucity of groundwater quality data in the immediate vicinity of the Thermalito Forebay and Afterbay. Most of the wells that have been previously monitored are several miles from the project, and the few wells nearer the project lack sufficient water quality data for determination of project effects. The Butte County Integrated Watershed and Resource Conservation Plan emphasizes water quality (Ed Craddock, pers. comm.). The County would like to see additional water quality monitoring to insure that the groundwater resources are being protected from contamination.

5.2 Task 1, Phase 2 – Groundwater Monitoring

The wells previously monitored in the vicinity of the Thermalito Forebay clearly indicate the effects of the project on groundwater levels. However, since groundwater levels have not been identified as a concern and extensive groundwater level monitoring is already being conducted in the area by DWR and Butte County, no additional groundwater level monitoring was proposed for Phase 2. Due to the paucity of groundwater quality data in the project area and local concern for groundwater quality, additional monitoring was proposed for Phase 2 to evaluate effects from the project on groundwater quality.

Water quality data collected from bottom waters at two sites in both the Thermalito Forebay and Afterbay (Figure 5.2-1) from April 2002 through October 2003 were compared to groundwater quality data collected for this study. Groundwater quality data were compared to surface water quality data to ascertain similarities and differences, as well as to Basin Plan standards and other criteria, goals, and objectives compiled by the Central Valley Regional Water Quality Control Board (CVRWQCB 2003). Average surface water quality data collected from SPW1 was used for comparison to

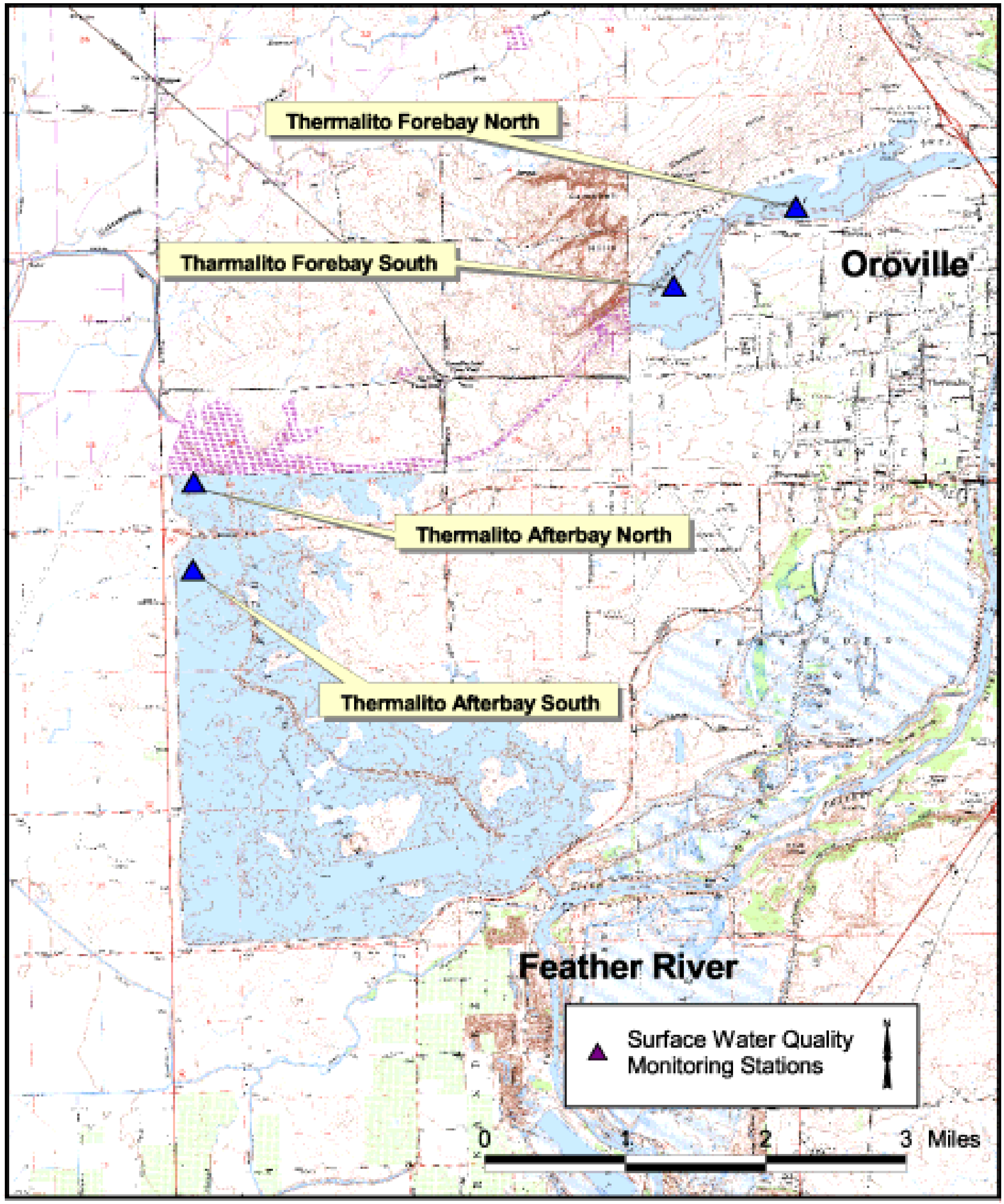

Figure 5.2-1. Surface water quality monitoring stations At Thermalito Forebay and Afterbay.

groundwater quality data collected in the spring and fall. Average surface water quality data were used since recharge to groundwater occurs continuously, groundwater moves slowly, and hence is not reflective of the surface water at any given moment. Average surface water quality would also be a better indicator of long-term characteristics of the project waters. For water temperatures, averages were not used because this would not be relative as this parameter can change quickly with seasonal variation and project operations. Instead, water temperatures obtained during the period in which groundwater was sampled were used (June through November 2003).

Also, to assess any impacts to either shallow or deep groundwater, wells drawing water from different depths were sampled. For this investigation, deep wells were those that only drafted water from 100 feet or deeper below the surface. While some of the wells designated as shallow were deeper than 100 feet, they were either perforated or had cases less than 100 feet below surface, allowing the water to be drafted from the shallower groundwater.

5.2.1 Physical Results

Physical parameter (temperature, pH, conductivity) measurements were made at the time of sample collection. Results from project waters collected as part of SPW1 (Appendix A) were compared to those collected from the groundwater sampling sites from this investigation (Appendix B).

Water temperatures from groundwater were collected from only eight wells because the majority of wells could not be sampled at the wellhead. Where water could not be collected from the wellhead, temperatures were not measured because this parameter could be affected by outside influences (such as surface heat when traveling through piping, hoses, storage tanks, etc.) that could alter the actual temperature of water from the well.

During the groundwater sample collection period (June through November), water temperatures exhibited a decline from both project waters and most groundwater locations, although the groundwater temperature change was not as steep with the exception of well A11 (Figure 5.2.1-1). Temperatures from the groundwater were generally warmer than the surface water, with a greater difference between the two during the fall sample collection. Three deeper wells that retrieve water from 100 feet or deeper had temperature decreases of 0.1, 0.8, and 1.8 ºF, while five shallower drafting wells ranged from no change at one well to a decrease of 5.6 ºF at another. One well upgradient from the project showed a decrease of 0.7 ºF. Only shallow well A11 reflected a change in water temperature that was similar to surface water changes as it fell by 5.6 ºF, similar to declines in the Thermalito Forebay (5.8 °F north, 6.3 °F south). However, water from this well was about 10 ºF warmer than either the north or south Forebay sampling areas.

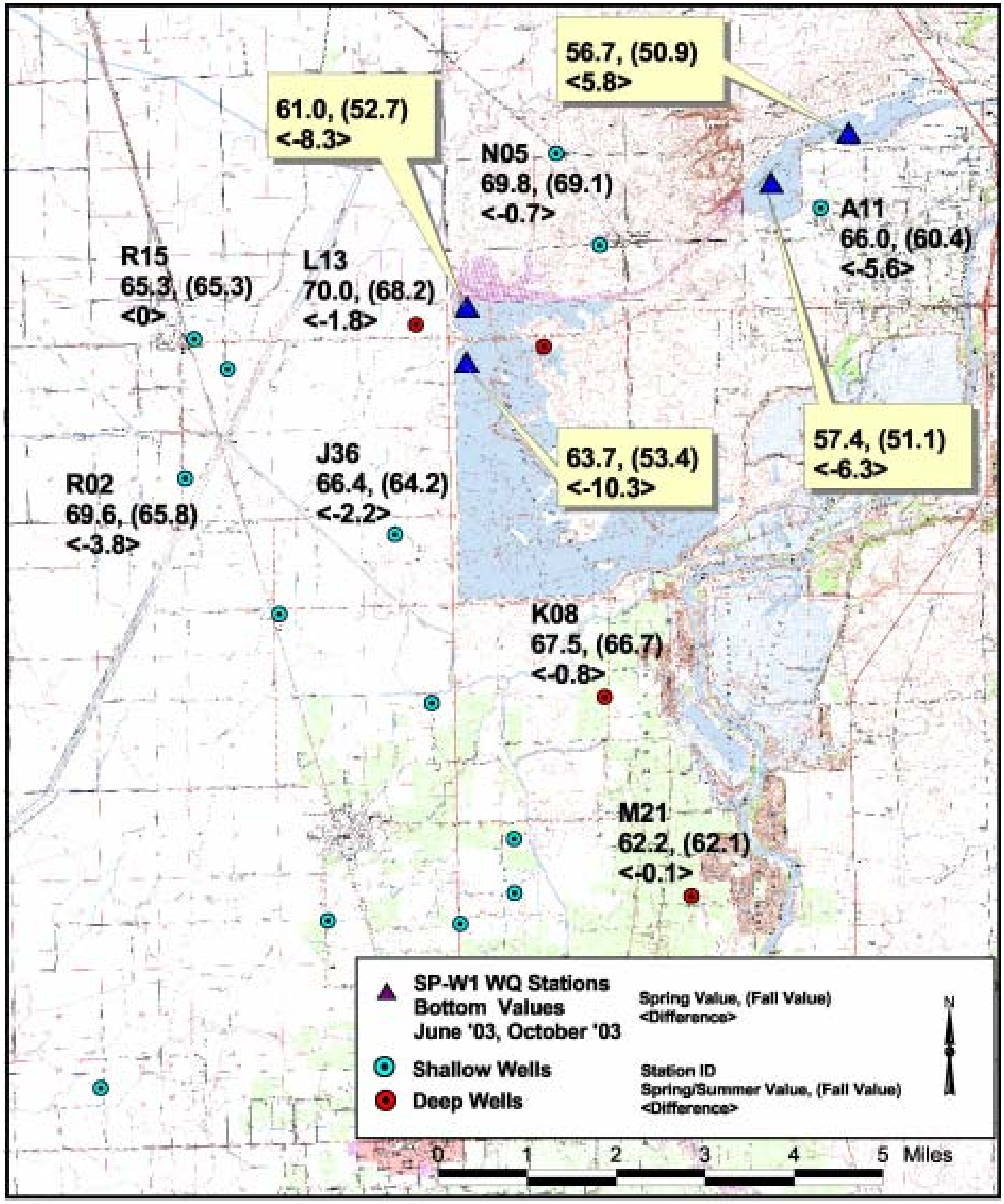

Figure 5.2.1-1. Comparison of groundwater and surface water results - water temperatures.

pH from the Thermalito Forebay and Afterbay ranged from 7.0 to 8.2 (averaging 7.3 to 7.5) between April 2002 and October 2003, while pH in groundwater ranged from 6.9 to 8.2, with only two wells exceeding 7.5 (Figure 5.2.1-2). Two deeper wells had pH values of 8.1 to 8.2, while two other deeper wells had values between 7.2 and 7.5. pH in shallow wells ranged from 6.9 to 7.5. One shallow well (J36) just west of the Thermalito Afterbay had pH values (6.9 to 7.1) which were lower than nearly all surface water measurements. pH values tended to be slightly higher to the southwest and west of the project than to the south. Groundwater pH values did not exceed any criteria.

All groundwater measurements of conductivity were much higher than average values from project waters (Figure 5.2.1-3). Project waters never exceeded 94 µmhos/cm, while the lowest measurement from groundwater was 124 µmhos/cm from shallow well A11. Deeper wells had water with conductivity values that ranged from 137 to 368 µmhos/cm. Conductivity from deeper wells increased with distance from the project waters, with the lowest values from L13 (137 µmhos/cm) and highest at M21 (368 µmhos/cm). Well L13 had values slightly lower than upgradient shallow wells, however there are no deep upgradient wells to which these results can be compared. Shallow wells had conductivity values much higher than project waters and ranged from 124 to 1,220 µmhos/cm. Only well A11 (124 µmhos/cm) had conductivity lower than upgradient wells, however it was still higher than all project water measurements. Three shallow wells (B23, M22, R15), on at least one occasion, exceeded the Food and Agriculture Organization water quality goal for agriculture of 700 µmhos/cm (CVRWQCB 2003). One well also exceeded the California Department of Health Services secondary Maximum Contaminant Level (MCL) of 900 µmhos/cm for conductivity on one occasion. Secondary MCL's are derived for human welfare considerations (taste, odor, aesthetics, etc.) in drinking water and not for health concerns.

5.2.2 Mineral Results

Dissolved calcium results from groundwater were higher than average surface water results from all wells except well A11 (Figure 5.2.2-1). Surface water results ranged from 7 to 10 mg/L. Upgradient wells had 10 to 14 mg/L, which is slightly higher than surface water results. Deep wells had calcium concentrations of 10 to 30 mg/L, with wells near the project waters similar to upgradient wells, and one well further away and to the south having much higher concentrations. All deep wells had calcium concentrations greater than found in project waters. Shallow wells ranged from 7 to 127 mg/L and had much higher levels of calcium than project waters, with the exceptions of well A11 which had results similar to surface water results, and well R02 which was slightly higher and similar to upgradient wells. There are no water quality criteria for calcium.

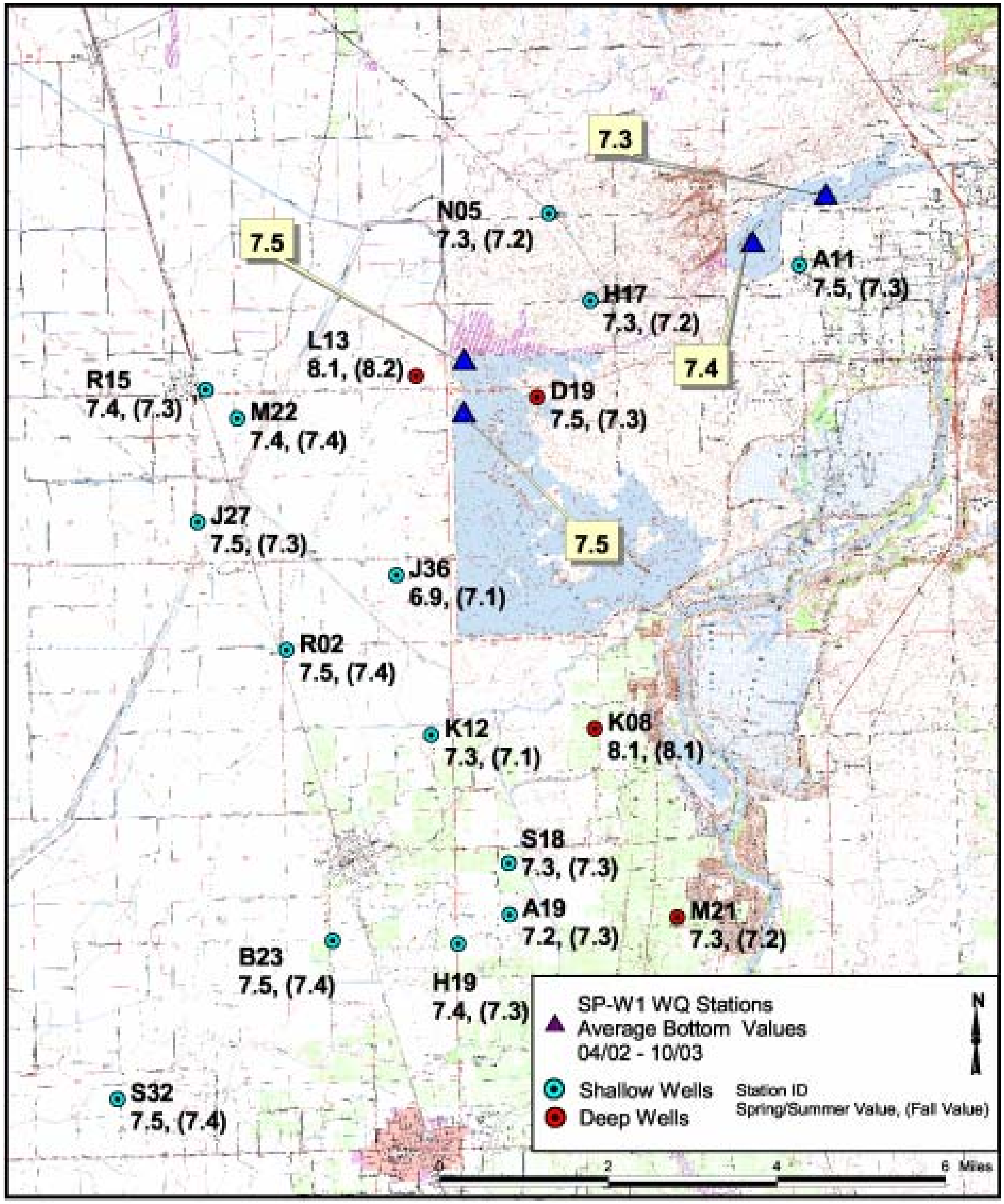

Figure 5.2.1-2. Comparison of groundwater and surface water results - pH measurements.

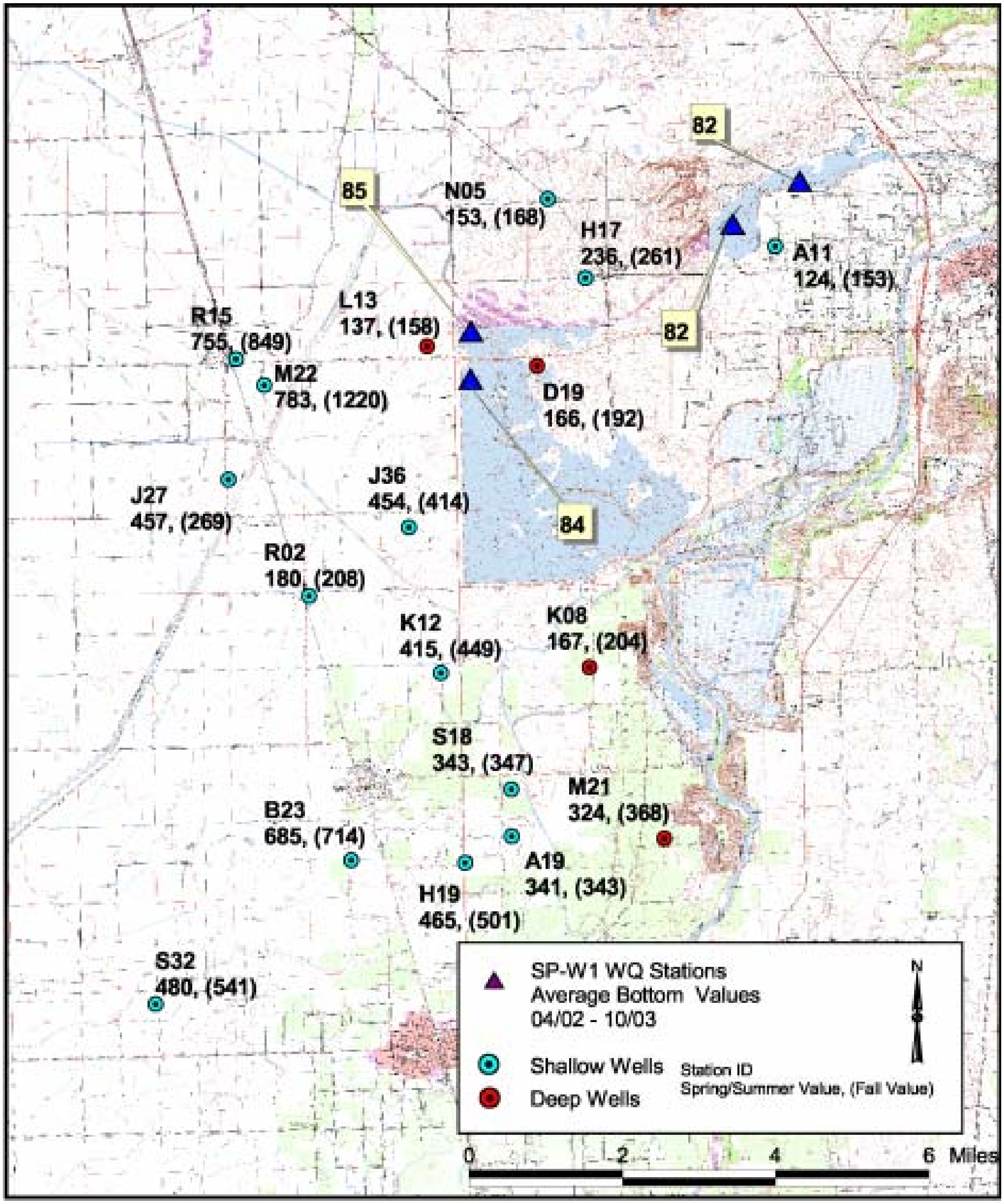

Figure 5.2.1-3. Comparison on groundwater and surface water results - conductivity.

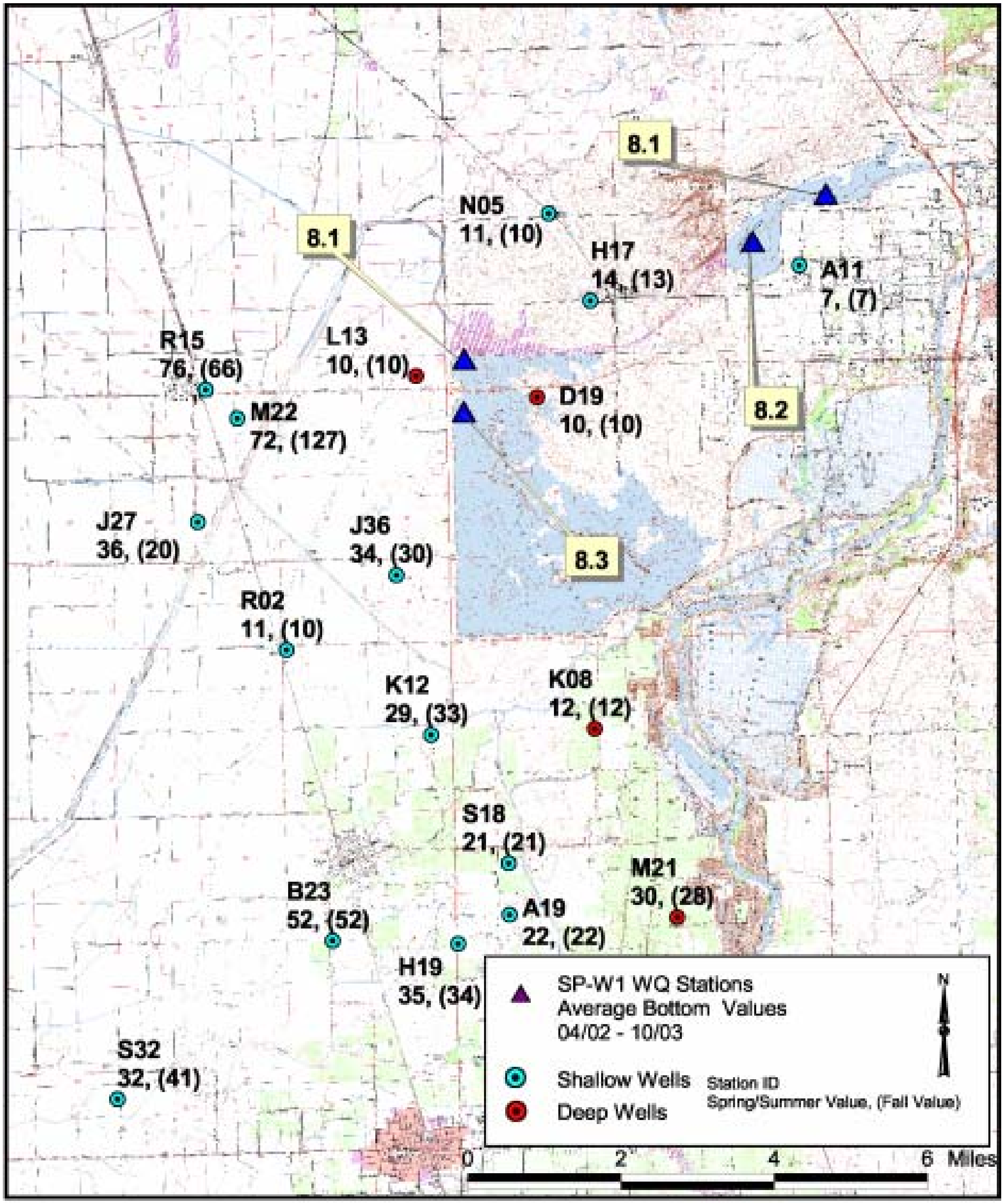

Figure 5.2.2-1. Comparison of groundwater and surface water results - dissolved calcium.

Dissolved potassium concentrations from groundwater were generally higher than those from project waters (Figure 5.2.2-2). Exceptions were wells A11 and H19, which had lower concentrations, and N05 and K12, which were similar. Project waters ranged from 0.6 to 1.0 mg/L, while groundwater ranged from less than 0.5 to 2.6 mg/L. Upgradient wells had results of 0.8 to 1.7 mg/L; one upgradient well was similar to project waters, while the other was higher. Potassium from deeper wells ranged from 1.3 to 2.6 mg/L, with all results higher than those from project waters. Shallow wells ranged from less than 0.5 to 2.8 mg/L. Downgradient wells generally had potassium concentrations between the values of the two upgradient wells, with the exceptions of A19 (1.9 mg/L) and S32 (2.4 to 2.8 mg/L) which were higher, and wells A11 (less than 0.5 to 0.6 mg/L), K12 (less than 0.5 to 0.6 mg/L), and H19 (less than 0.5 to 0.5 mg/L) which were lower. There are no water quality criteria for potassium.

Dissolved magnesium concentrations from groundwater were generally much higher than levels from surface water (Figure 5.2.2-3). Results from project waters ranged from 3 to 4 mg/L, while the groundwater ranged from 4 to 71 mg/L. Upgradient wells ranged from 8 to 14 mg/L, which is twice that of project waters. All downgradient wells had results similar or much higher then upgradient wells, and all were higher than project waters. The lowest groundwater result at well A11 in the spring was equal to the maximum project water result, while the fall measurement at this same well was more than twice the maximum surface water result obtained. Three deeper wells ranged from 8 to 10 mg/L, while the furthest deep well (M21) ranged from 25 to 27 mg/L. Magnesium levels in shallow wells ranged from 4 to 71 mg/L. There are no water quality criteria for magnesium.

Dissolved sodium concentrations from groundwater sources were higher than surface water averages (Figure 5.2.2-4). Project waters ranged from 3 to 4 mg/L, while groundwater samples ranged from 5 to 48 mg/L. Upgradient wells had sodium results (11 to 16 mg/L) about three to four times the maximum surface water result. Downgradient wells ranged from slightly below upgradient results (5 to 11 mg/L at A11 and 7 to 8 mg/L at M21) to much higher.

Deep well sodium concentrations ranged from 7 to 14 mg/L, while shallow wells ranged from 5 to 48 mg/L. Four groundwater wells had sodium results that exceeded the USEPA draft drinking water advisory level of 20 mg/L, and two of these wells also had results at or above the USEPA Drinking Water Advisory taste and odor threshold of 30 to 60 mg/L (CVRWQCB 2003).

Dissolved boron was detected in the fall from well K08 at the minimum laboratory detection limit of 0.1 mg/L. No other sample collections from either surface water or groundwater had boron at detectable levels. Therefore, no results from groundwater sampling exceeded any criteria for boron.

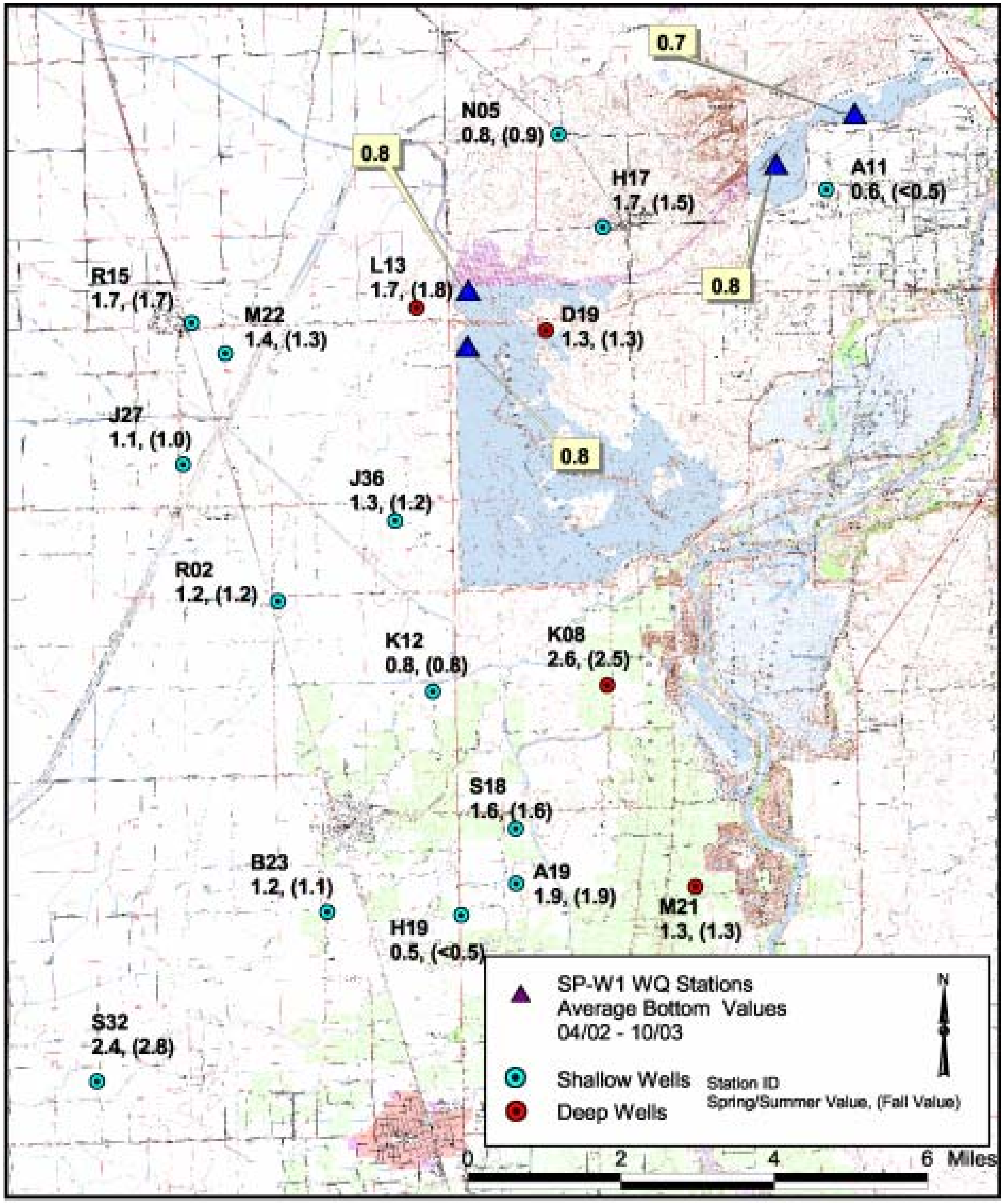

Figure 5.2.2-2. Comparison of groundwater and surface water results - dissolved potassium.

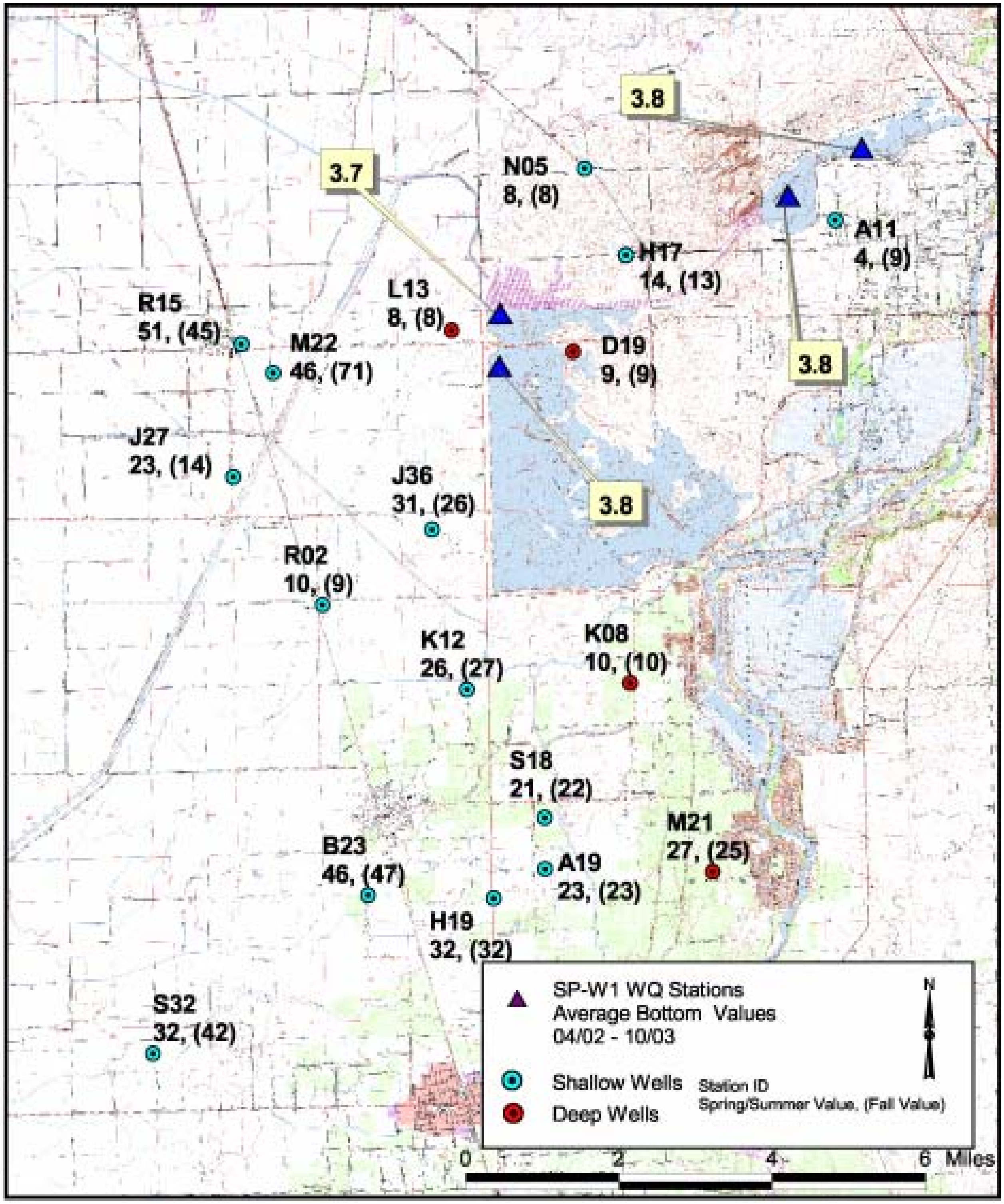

Figure 5.2.2-3. Comparison of groundwater and surface water results - dissolved magnesium.

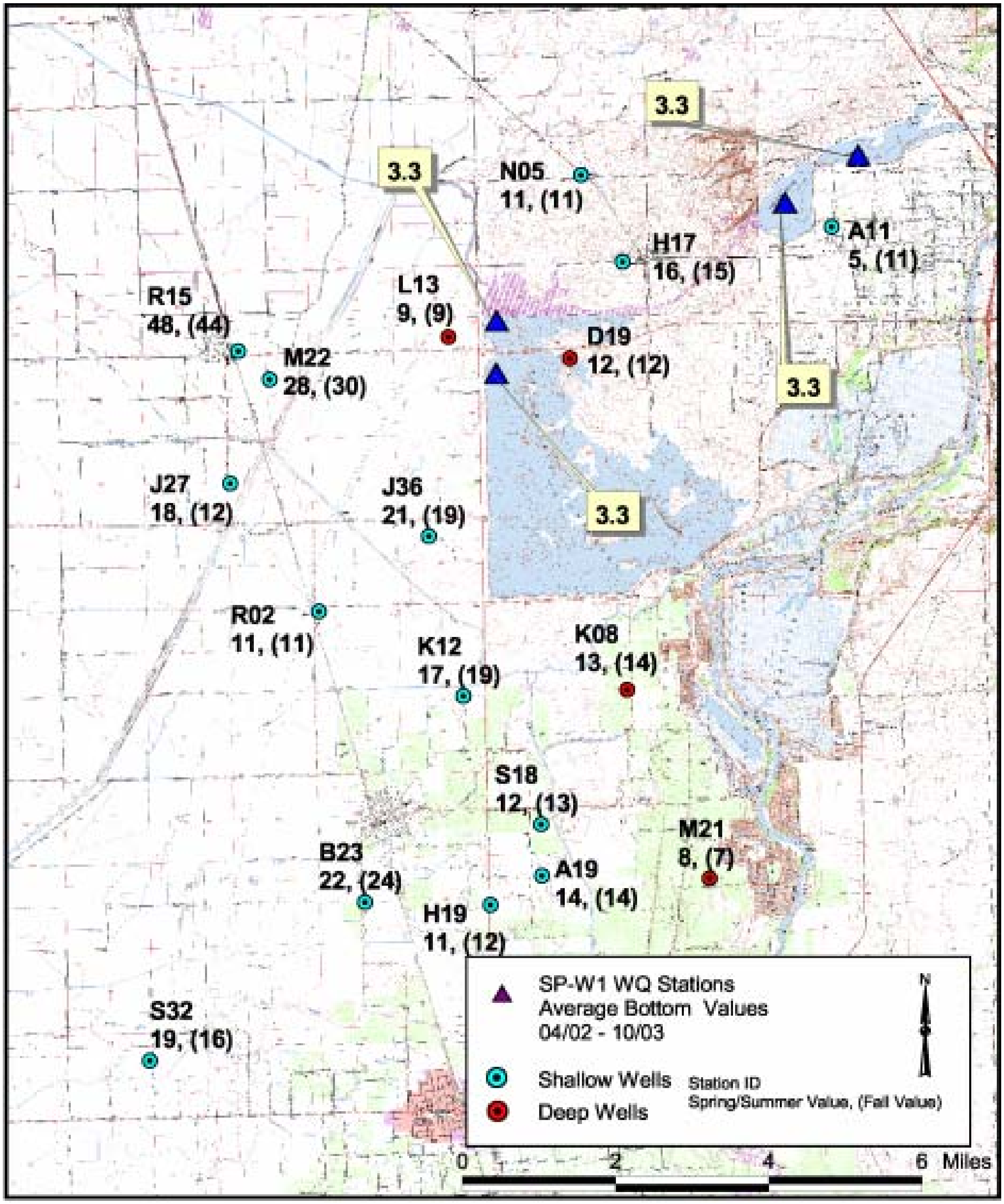

Figure 5.2.2-4. Comparison of groundwater and surface water results - dissolved sodium.

Dissolved chloride from the Thermalito Forebay and Afterbay was generally at the lab minimum detection level of 1 mg/L or less, while all groundwater results were greater than 2 mg/L (Figure 5.2.2-5). Upgradient wells had chloride levels of 7 to 9 mg/L, which were higher than many downgradient wells and the project waters. Deeper wells ranged from 2 to 7 mg/L, and were generally slightly lower than upgradient wells and higher than project waters. Shallow wells ranged from 2 to 29 mg/L, with several wells having chloride concentrations lower than upgradient wells, but higher than project waters. Other shallow wells had chloride concentrations much higher than upgradient wells. Results from groundwater sampling did not exceed any criteria for chloride.

Dissolved sulfate from groundwater ranged from below laboratory detection levels to 195 mg/L, while sulfate from the Thermalito Forebay and Afterbay was 2 mg/L on each sampling occasion (Figure 5.2.2-6). All groundwater wells had concentrations of dissolved sulfate that were higher than project waters, with the exception of deep well L13 (less than 1 to 1 mg/L) and shallow well A11 (1 to 6 mg/L). Upgradient wells ranged from 2 to 9 mg/L, with one well similar to project waters and the other with higher concentrations of dissolved sulfate. Downgradient wells ranged from less than 1 to 195 mg/L. Deeper downgradient wells ranged from less than 1 to 21 mg/L, while shallow downgradient wells ranged from 1 to 195 mg/L. Results from groundwater sampling did not exceed any criteria for sulfate.

Total alkalinity (a measurement of primarily carbonate, bicarbonate, and hydroxide) from groundwater was higher than project water averages from all wells (Figure 5.2.2-7). Total alkalinity concentrations from the Thermalito Forebay and Afterbay ranged from 34 to 53 mg/L, while groundwaters ranged from 44 to 437 mg/L. Upgradient wells had higher alkalinity than project water results but much lower than most downgradient wells, with the exceptions of L13, D19, and R02 which fell between the upgradient well results. Deep wells ranged from 77 to 162 mg/L, with two wells (L13 and D19) having results between upgradient results, and two other deep wells had slightly higher results from one (K08) and much higher at the other (M21). Shallow wells had results generally much higher than upgradient wells or surface waters, with the exceptions of R02 which had similar results to upgradient wells, and A11 which had one result below upgradient well results and similar to project water results, with the fall result from this well greater than project water results. Results from groundwater sampling did not exceed any criteria for alkalinity.

Total dissolved solids (TDS) results obtained from groundwater monitoring ranged from 75 to 801 mg/L, with all results higher than those found in project waters which ranged from 34 to 65 mg/L and averaged 51 to 53 mg/L (Figure 5.2.2-8). Upgradient wells ranged from 101 to 200 mg/L. Deeper wells ranged from 89 to 225 mg/L, with three wells having TDS values from 89 to 133 mg/L, while well M21 was higher (210 to 225 mg/L). Deep well L13 had one TDS value of 89 mg/L, which was lower than both upgradient well values but still higher than project water results. Shallow wells had TDS results from 75 to 801 mg/L, which were much higher then project water results.

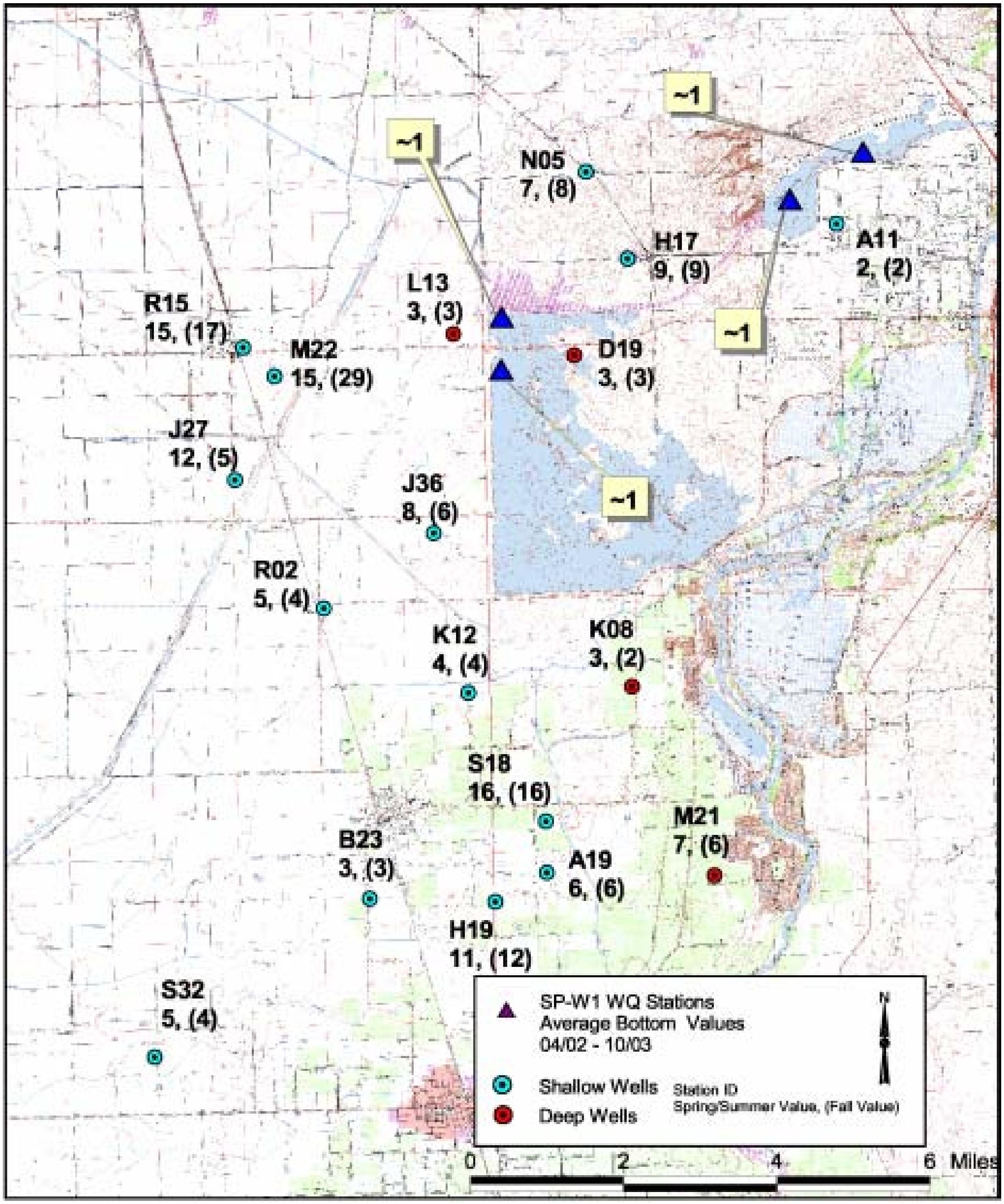

Figure 5.2.2-5. Comparison of groundwater and surface water results - dissolved chloride.

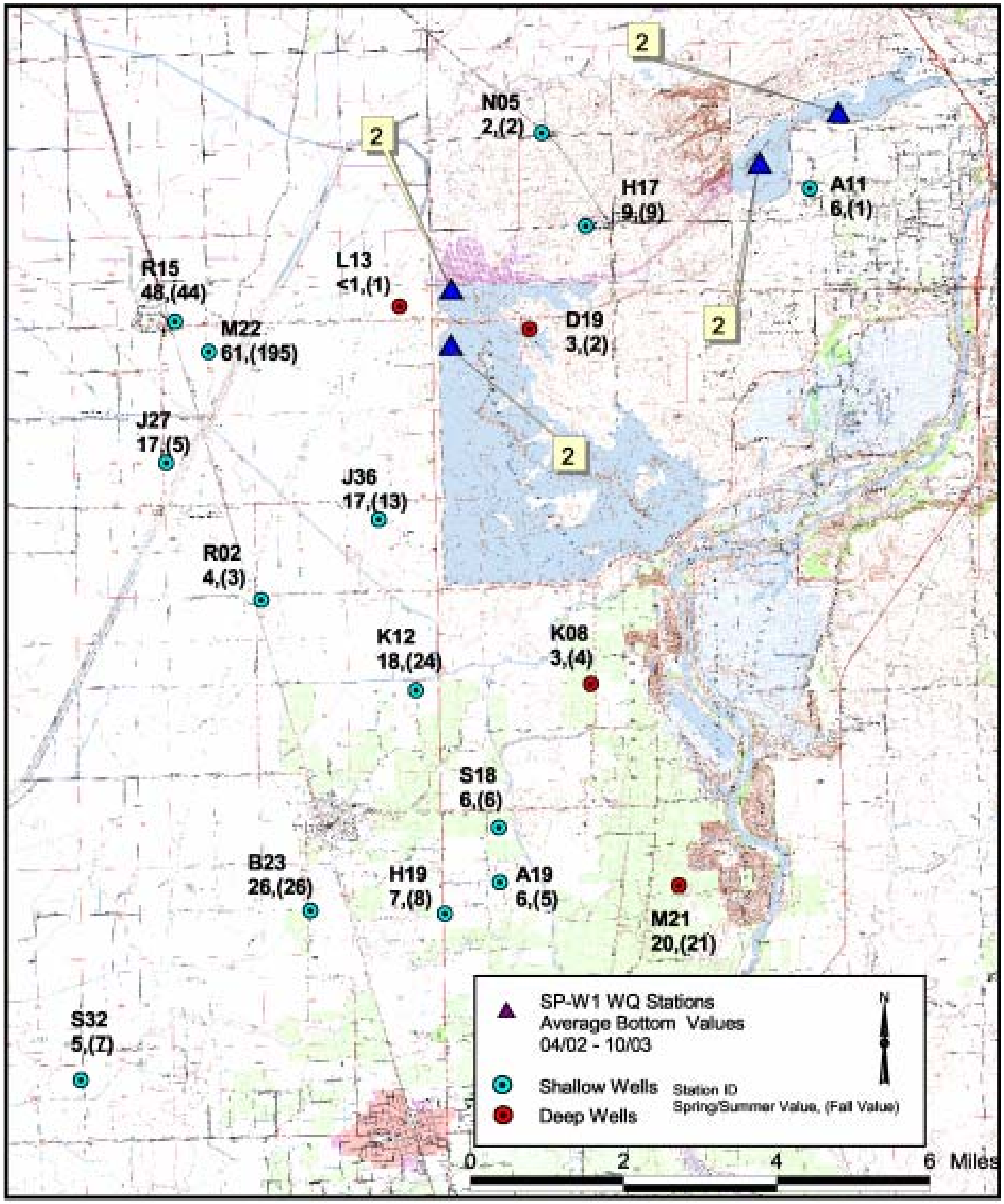

Figure 5.2.2-6. Comparison of groundwater and surface water results - dissolved sulfate.

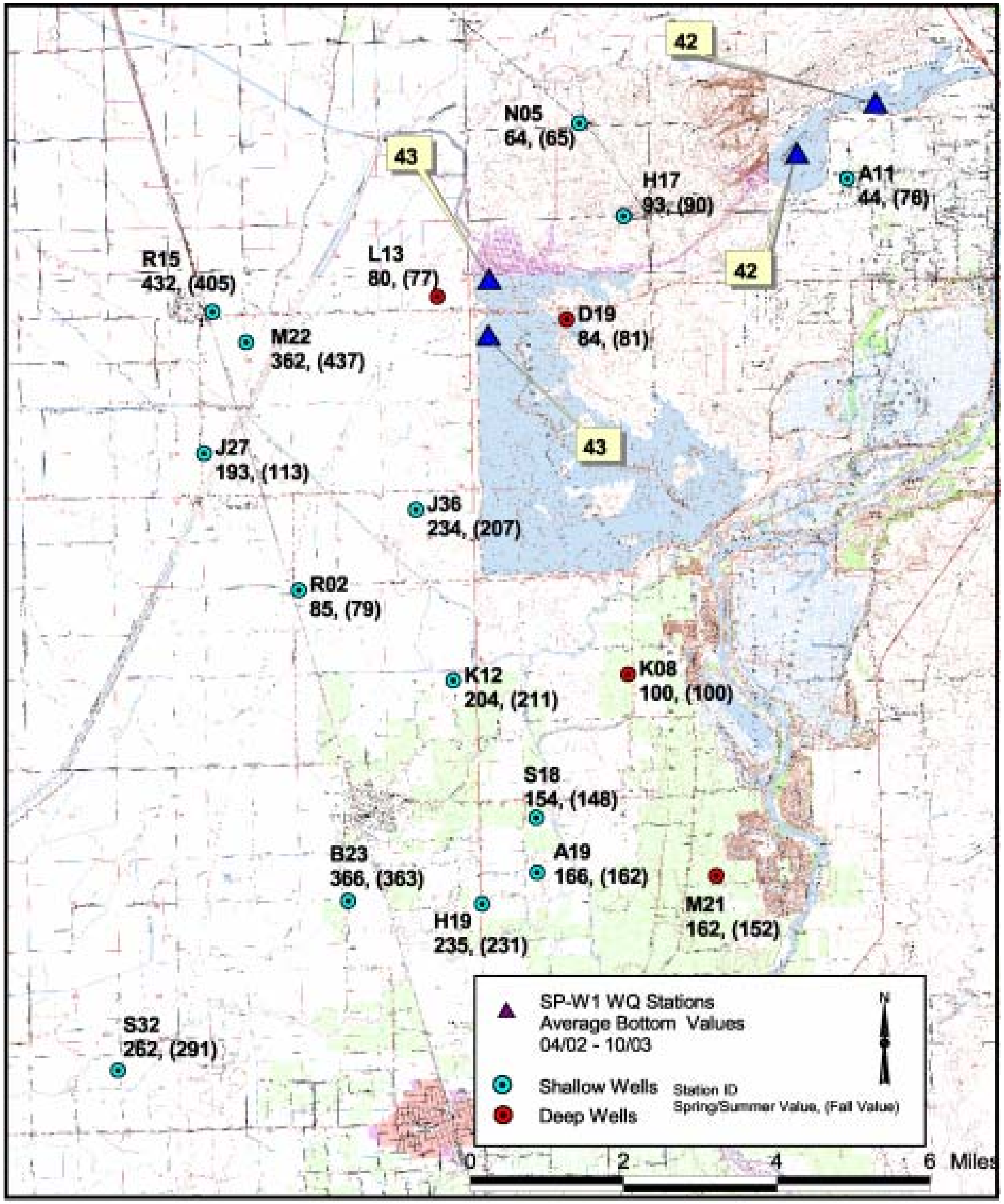

Figure 5.2.2-7. Comparison of groundwater and surface water results – total alkalinity.

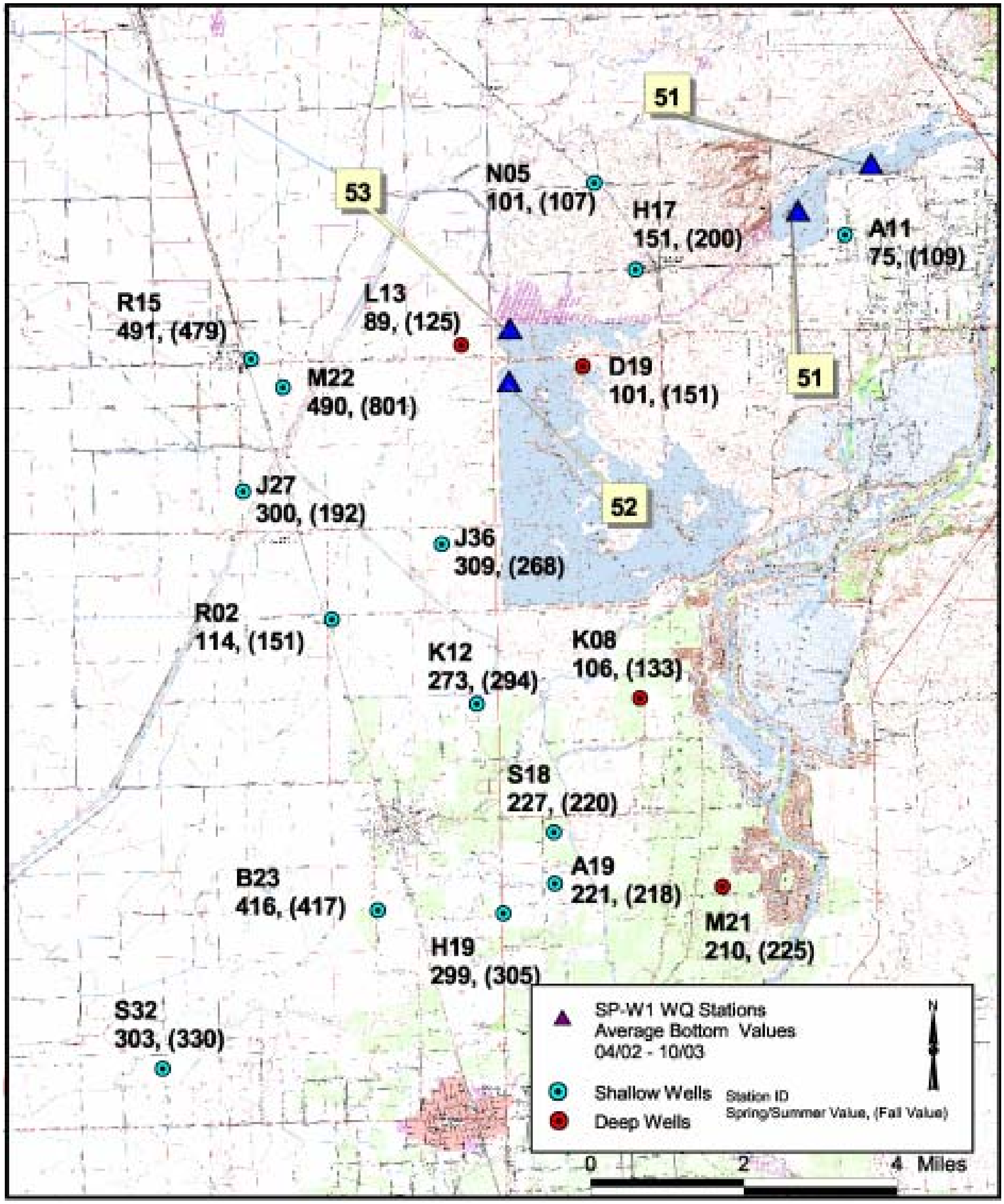

Figure 5.2.2-8. Comparison of groundwater and surface water results – total dissolved solids.

Shallow wells also had TDS values much higher than water from upgradient wells, with the exception of wells A11 and R02. A11 had 75 mg/L on the first sampling occasion, which is lower than upgradient results. Wells R02 and A11 (on the second sampling occasion) had TDS results between the results from both upgradient wells. Shallow wells M22 and R15 exceeded the Food and Agriculture Organization water quality goal for agriculture of 450 mg/L, and M22 also exceeded the California DHS and USEPA secondary MCL of 500 mg/L (CVRWQCB 2003).

Dissolved hardness values in the groundwater ranged from 34 to 400 mg/L, and were higher than project waters (which never exceeded 41 mg/L) with the exception of well A11 (Figure 5.2.2-9). Upgradient wells ranged from 58 to 93 mg/L, while downgradient wells ranged from 34 to 400 mg/L. Deeper wells ranged from 58 to 71 mg/L and were similar to upgradient wells, with the exception of well M21 which was higher at 173 to 186 mg/L. Shallow wells had hardness values of 34 to 400 mg/L, with most values much higher than upgradient wells and project waters. Exceptions were well R02 which was similar to upgradient wells but higher than surface waters, and well A11 which was lower than upgradient wells on both occasions. Well A11 on the first occasion had a hardness value (34 mg/L) similar to project water, but the second result (55 mg/L) was much higher. There are no water quality criteria for hardness.

5.2.3 Metals Results

Results of total aluminum analyses from groundwater ranged from 1.08 to 33.3 ug/L, except at well A11 from which 54.8 ug/L of total aluminum was reported. Concentrations of total aluminum averaged 52.35 to 76.94 µg/L in the Thermalito Forebay and 79.5 to 91.19 µg/L in the Thermalito Afterbay. All groundwater results were lower than averages from project waters (Figure 5.2.3-1). The lowest value obtained from the surface waters (11 µg/L) was higher than results from all but four (A11, J36, L13, and M22) groundwater wells. Of these wells, A11, J36 and M22 are shallow, and L13 is deep. Results from the groundwater monitoring were fairly similar in regards to upgradient versus downgradient, and between shallow and deep wells, with the exceptions of the previously mentioned four wells and deep well K08, which had total aluminum concentrations slightly higher than upgradient results on each sampling event. Results from these wells were closer to results from project waters than most of the wells sampled. Well A11, with a total aluminum concentration from spring sampling of 54.8 µg/L, was within the USEPA secondary MCL range for aluminum of 50 to 200 µg/L (CVRWQCB 2003). Groundwater in the vicinity of this well is heavily influenced by surface water (Figure 5.1.2-2).

Results for dissolved aluminum analyses from groundwater ranged from 0.52 to 9.97 ug/L, with the exception of well A11 in which dissolved aluminum from the spring sample was reported to be 54.9 ug/L. This exceptionally high level is probably a laboratory error, since surface waters, which heavily influence groundwater levels in the vicinity of this well, contained only 9.87 to 10.59 ug/L of dissolved aluminum.

Concentrations of dissolved aluminum averaged 9.87 to 10.59 µg/L in the Thermalito Forebay and 11.30 to 13.09 µg/L in the Thermalito Afterbay (Figure 5.2.3-2). Shallow wells upgradient from project waters contained dissolved aluminum at much lower concentrations, which ranged from 0.79 to 1.36 µg/L in the spring and 1.04 to 1.62 µg/L in the fall. Dissolved aluminum in shallow wells downgradient from project waters, with the exception of well A11 which was probably reported in error, ranged from 0.52 to 2.80 µg/L in the spring

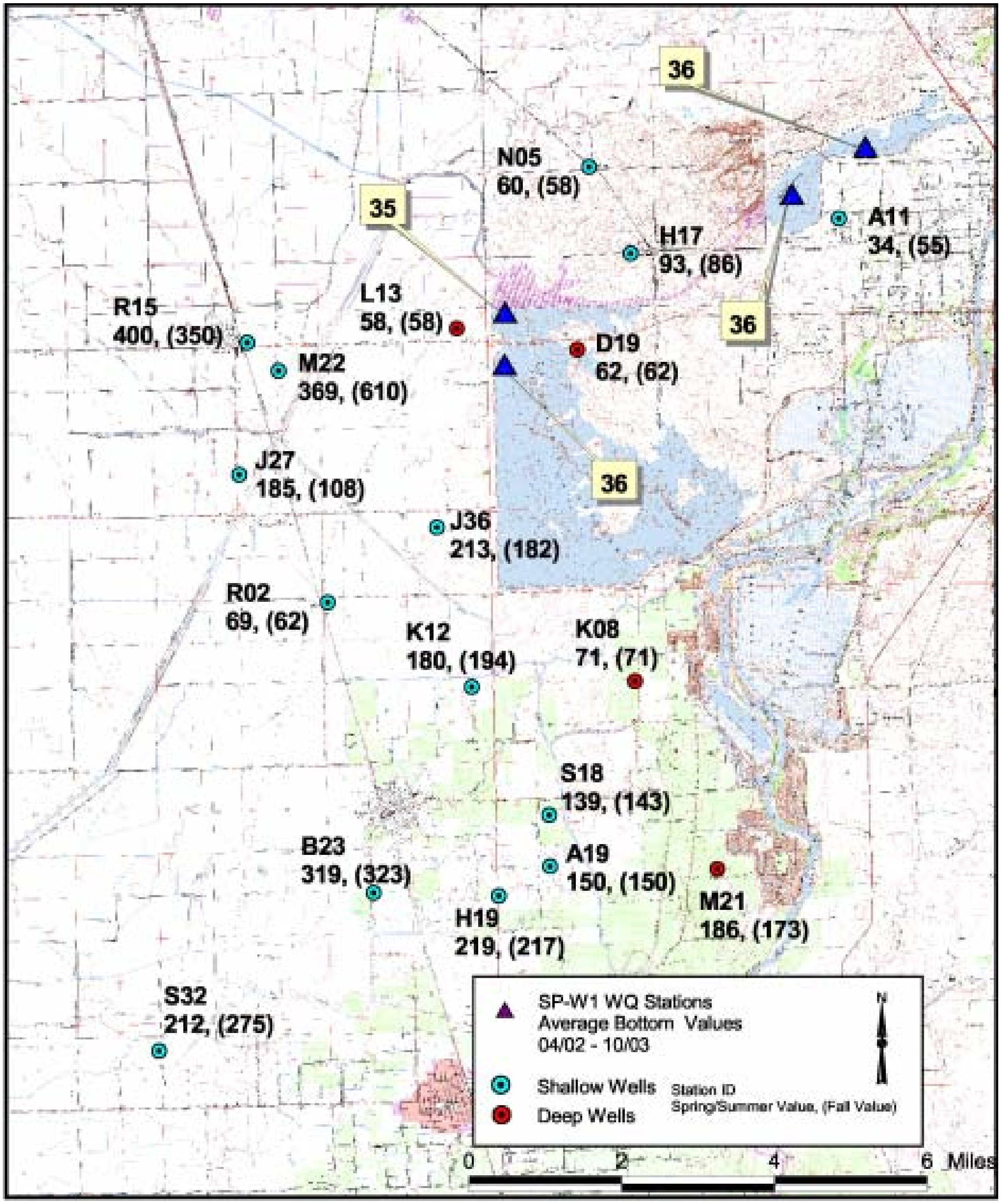

Figure 5.2.2-9. Comparison of groundwater and surface water results – dissolved hardness.

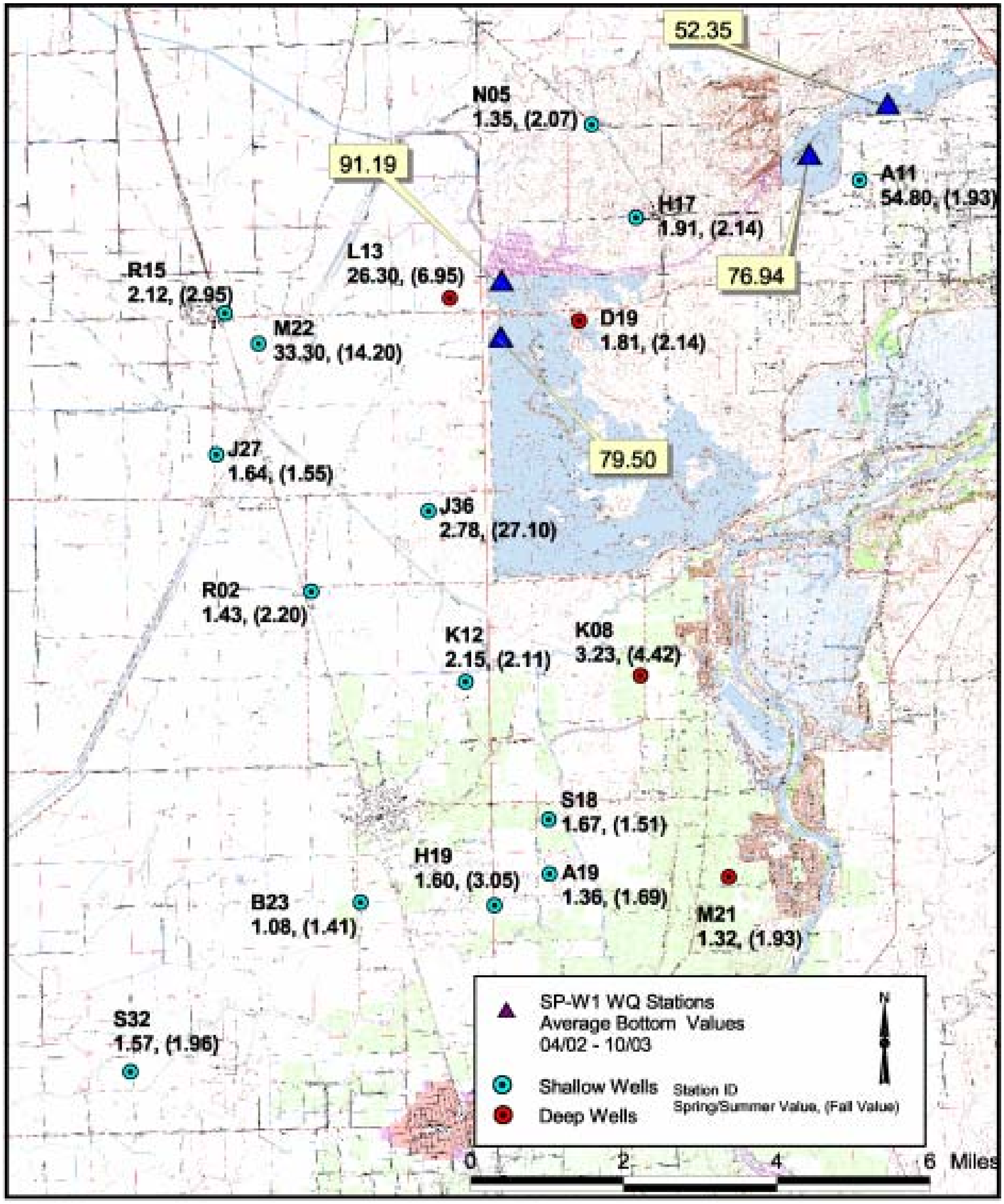

Figure 5.2.3-1. Comparison of groundwater and surface water results – total aluminum.

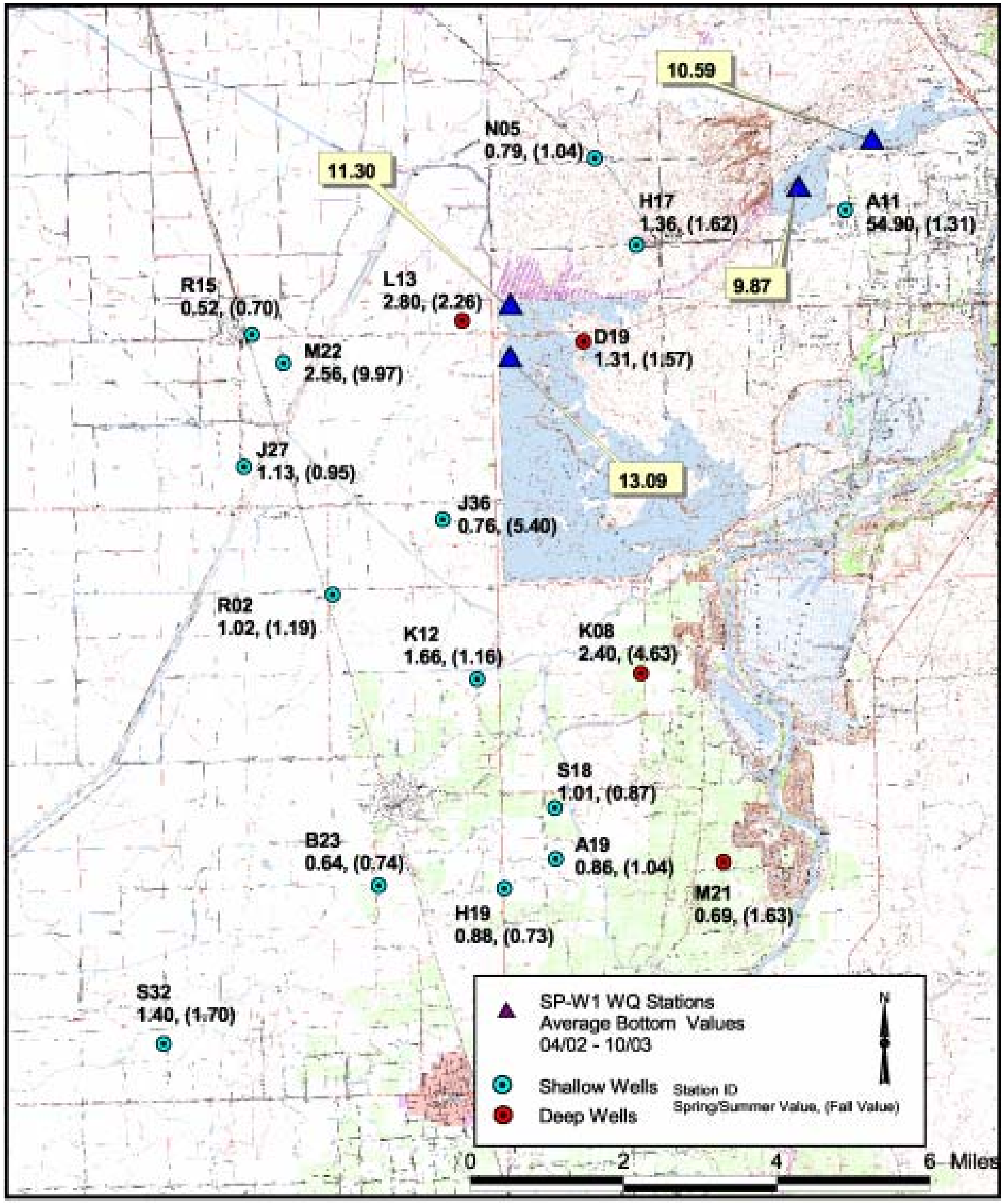

Figure 5.2.3-2. Comparison of groundwater and surface water results – dissolved aluminum.

. Concentrations of dissolved aluminum during the fall from shallow wells ranged from 0.70 to 9.97 µg/L. Concentrations of dissolved aluminum increased significantly in the two shallow wells nearest the west side of the Afterbay, though concentrations in shallow wells equally distant to the southwest decreased by the fall. Concentrations of dissolved aluminum in deep wells were similar to those found in shallow wells, and ranged from 0.69 to 2.80 µg/L in the spring and 1.57 to 4.63 µg/L in the fall.

Mercury results from groundwater monitoring ranged from less than 0.00015 to 0.00156 µg/L, while project waters widely ranged from less than 0.00015 to 0.0366 µg/L and averaged from 0.000766 from the south Forebay to 0.002499 from the south Afterbay (Figure 5.2.3-3). Upgradient wells ranged from less than 0.00015 to 0.00038 µg/L. Two deep wells had mercury concentrations of less than 0.00015, while the other two deep wells had reported concentrations of 0.00046 and 0.00060 µg/L. Shallow wells ranged from less than 0.00015 to 0.00156 µg/L. Wells to the west and southwest tended to have mercury at higher concentrations than wells to the south. Many downgradient wells had mercury concentrations similar to upgradient values. None of the results from groundwater monitoring exceeded any water quality criteria.

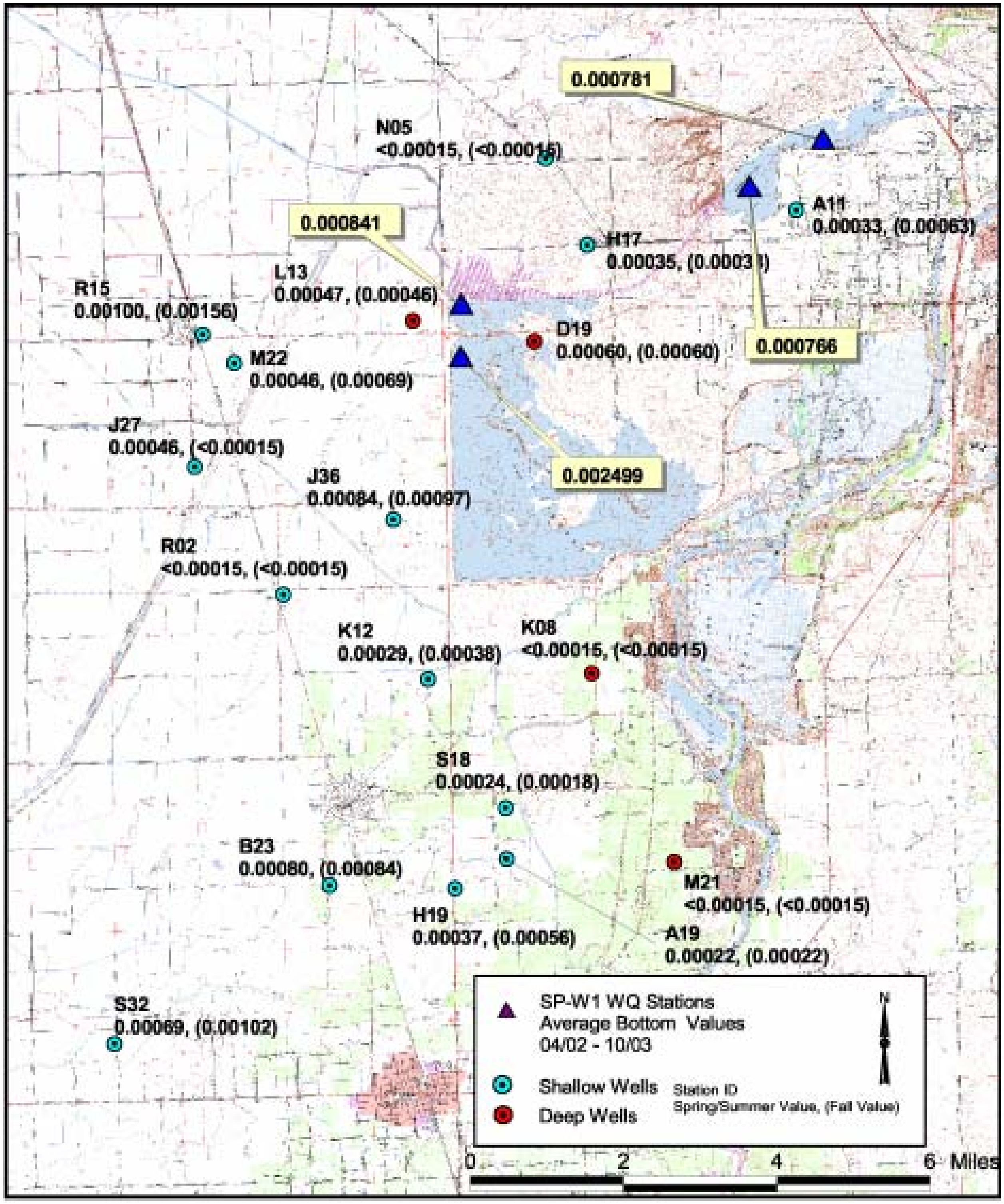

Figure 5.2.3-3. Comparison of groundwater and surface water results – total mercury.

6.0 ANALYSES

The purpose of Task 1 of this study was to determine any project effects to the local groundwater levels or quality in the area of the Thermalito Forebay and Afterbay. This included an analysis of groundwater level data, and also required comparison of local groundwater quality data to surface water quality data from the Thermalito Forebay and Afterbay collected from a separate study. Groundwater wells upgradient from the surface water features were sampled as a baseline. The results of the groundwater quality measurements were also compared to published criteria (CVRWQCB 2003).

6.1 EXISTING CONDITIONS/ENVIRONMENTAL SETTING

6.1.1 Groundwater Levels

The wells previously monitored in the vicinity of the Thermalito Forebay clearly indicate the effects of the project on groundwater levels. Two wells potentially affected by the Thermalito Forebay had been monitored for water levels from 1959 to 1982. These wells show that groundwater elevation was increased by about 10 feet following project completion in 1969.

6.1.2 Groundwater Quality

6.1.2.1 Physical Parameters

Results show that temperatures of the surface waters and several area wells decreased over the sampling period. Both deep and shallow wells showed decreases, as did an upgradient well. Decreases in groundwater temperatures were of a lesser extent than surface waters, which had temperature changes as much as 10.3 ºF lower in the fall than the spring, while groundwater temperatures decreased by 5.6 ºF or less.

pH in the groundwater was generally slightly lower than surface water averages, with the exception of two deep wells which had pH values that were much higher, and one shallow well that was much lower. pH values to the south of project waters were slightly lower than those to the southwest and west, and were similar to upgradient well values. Groundwater pH values did not exceed any water quality criteria.

Conductivity was greater in both shallow and deep groundwater than project waters, with shallow groundwater conductivity generally much higher than that from deeper wells. Three shallow wells, on at least one occasion, exceeded the FAO water quality goal for agriculture of 700 µmhos/cm. One well also exceeded the California DHS secondary MCL of 900 µmhos/cm for conductivity on one occasion. Secondary MCL's are derived for human welfare considerations (taste, odor, aesthetics, etc.) and not for health concerns.

6.1.2.2 Mineral Parameters

Results from mineral analyses, including alkalinity, hardness, and total dissolved solids, indicate that minerals are generally at much higher concentrations in area groundwater than is found in the Thermalito Forebay and Afterbay. This includes wells upgradient from the Thermalito Afterbay, and both deep and shallow wells. Mineral concentrations from deeper wells were generally lower than shallow groundwater; however they are still substantially higher than project waters.

Minerals from groundwater that exceed water quality criteria include sodium and total dissolved solids. Four groundwater wells had sodium concentrations that exceed the USEPA draft drinking water advisory level of 20 mg/L, and two of these wells also had mineral concentrations at or above the USEPA Drinking Water Advisory taste and odor threshold of 30 to 60 mg/L. TDS values from shallow wells M22 and R15 exceed the FAO water quality goal for agriculture of 450 mg/L, and M22 also exceeds the California DHS and USEPA secondary MCL of 500 mg/L.

6.1.3.2 Metal Parameters

While total aluminum from surface water exceeded criteria on numerous occasions, groundwater from only one shallow well near the Thermalito Forebay exceeded criteria for total aluminum. Five wells near the project waters had total and dissolved aluminum concentrations higher than upgradient wells, but these results were well below any criteria.

Mercury results are generally similar between upgradient and downgradient wells and lower than results from the project waters. Results for mercury analyses do not indicate that project waters are impacting local groundwater. While some downgradient wells have mercury results higher than upgradient wells, there is nothing to suggest that this is not a natural characteristic of the groundwater as not all wells shared this phenomenon. Many of the wells to the south and southwest had values between the results of upgradient wells, and mercury concentrations on several occasions did not reach detectable limits in both shallow and deep wells.

The only well that exceeded any water quality criteria for metals was well A11, which had a total aluminum concentration that was within the USEPA secondary MCL range.

6.3 PROJECT RELATED EFFECTS

6.3.1 Project Effects on Groundwater Level

The wells previously monitored in the vicinity of the Thermalito Forebay clearly indicate the effects of the project on groundwater levels. Groundwater levels have not been identified as a concern, and since extensive groundwater level monitoring is already being conducted in the area by DWR and Butte County, no groundwater level monitoring was conducted for Phase 2 of this investigation.

6.3.2 Project Effects on Groundwater Physical Parameters

Results from temperature measurements indicate there is probably no extensive impact from the project on temperatures in area groundwater. While several area wells reflected a decrease in temperatures, only one well showed a decrease in temperatures similar to surface water changes. There is insufficient evidence to indicate that the decrease in groundwater temperatures over the summer is not a natural occurrence in the groundwater as one well upgradient from the Thermalito Afterbay also had lower temperatures during the fall sampling.

There is no indication that project waters are impacting pH in groundwater as pH values in groundwater are fairly uniform throughout the area. Most wells have values similar to upgradient wells, with slightly higher values to the west and southwest. Several wells to the south of the project waters and just west of the Thermalito Afterbay had pH values lower than average surface water pH measurements, indicating that they are probably not being affected by project waters. Wells to the west and southwest of the project waters have pH values slightly higher than upgradient wells, suggesting that they may be influenced by the higher pH values from surface water, but this is not indicated by the lower values to the south that should also have been influenced. These slightly higher values to the southwest and west are more likely due to natural soil influences on the groundwater.

There is no indication of any impact from project water to groundwater conductivity. All groundwater conductivity measurements are much higher than surface water. Nearly all shallow wells have conductivity values much higher than found in upgradient wells. Deep wells have values similar to upgradient wells and increase with distance from the project waters, and shallow wells have downgradient conductivity values much higher than surface waters. If there is any impact occurring from the project waters, it would be a beneficial one as the conductivity values from the surface water is much lower and would dilute the area groundwater. This cannot be substantiated however, as most downgradient wells have higher values than upgradient wells, indicating the effects of local soil characteristics on groundwater quality.

6.3.3 Project Effects on Groundwater Mineral Parameters

Results from mineral analyses are probably the best indicator that the project waters are not impacting local groundwater. All of the wells have higher mineral concentrations than found in the Thermalito Forebay and Afterbay. Mineral concentrations generally increased as the valley floor was encountered. Mineral concentrations in the deeper groundwater, while lower than shallow groundwater, were still higher than results from surface waters. With mineral concentrations in project waters lower than local groundwater, there does not appear to be any negative impact upon local groundwater, since, even if surface waters were percolating to the groundwater aquifer, the much better quality surface water would actually be improving the poorer quality groundwater.

6.3.4 Project Effects on Groundwater Metal Parameters

There is no indication of impacts from metals upon the local area groundwater by the project waters. While a few wells have metal concentrations slightly higher than found in upgradient wells, this is not a characteristic shared by the majority of wells from which results are similar to or lower than values from upgradient wells. If any impact is occurring, it is highly localized near the project waters. However, this is not a characteristic shared by other parameters from these wells making this scenario unlikely.

6.4 SUMMARY OF PROJECT RELATED EFFECTS

Results from Phase 1 and 2 of this study do not indicate any adverse effects to groundwater levels or quality from the Thermalito Forebay or Afterbay. If there are any subtle effects to groundwater from the project facilities, the effects would be beneficial since groundwater levels would be recharged from project facilities and the naturally high mineral content of the groundwater would be diluted with surface water containing much lower mineral levels, resulting in better suitability for all beneficial uses. There is no indication from the water quality monitoring data that physical parameters, other minerals, or metals from surface waters are altering groundwater composition.

7.0 REFERENCES

APHA 1998. Standard Methods for the Examination of Water and Wastewater, 20th edition. American Public Health Association, American Water Works Association, and Water Environment Federation. Baltimore, Maryland.

CVRWQCB 2003. A Compilation of Water Quality Goals. California Environmental Protection Agency, Central Valley Regional Water Quality Control Board. Sacramento, California.

DWR 1994. Sampling Manual for Environmental Measurement Projects. Department of Water Resources. Sacramento, California.

USEPA 1996. Method 1669: Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels. U. S. Environmental Protection Agency. Cincinnati, Ohio.

8.0 APPENDICES

Appendix A. SPW1 surface water quality physical data and criteria.

Station Name	Date	Time (pst)	Depth (m)	Temp (°C)	Temp. (°F)	pH	Specific Conductance (field) µmhos/cm	Alkalinity mg/L CaCO3	TDS mg/L
USEPA Secondary MCL						6.5-8.5			500
California DHS Secondary MCL							900		500
USEPA MCL Goal (Taste & Odor)									500
California DHS Secondary MCL (Taste & Odor)							900		
Water Quality For Agriculture Goal						6.5-8.4	700		450
USEPA Nat. Ambient Water/Instant. Min & Max						6.5-9			
USEPA Nat. Ambient Water/Taste & Odor						5-9			250
CVRWQCB Basin Plan-Feather River							150		
Thermalito Forebay, north	04/02/02	1215	Btm	11.3	52.3	7.4	89	42	56
Thermalito Forebay, north	04/29/02	0845	Btm	10.0	50.0	7.6	90	n/a	59
Thermalito Forebay, north	05/22/02	1030	Btm	10.9	51.6	7.3	65	41	36
Thermalito Forebay, north	06/17/02	1145	Btm	14.9	58.8	7.4	84	40	56
Thermalito Forebay, north	07/18/02	1300	Btm	13.9	57.0	7.2	90	42	
Thermalito Forebay, north	08/19/02	1100	Btm	13.6	56.5	7.1	88	40	55
Thermalito Forebay, north	09/17/02	0800	Btm	10.6	51.1	7.2	91	n/a	57
Thermalito Forebay, north	10/22/02	0950	Btm	12.6	54.7	7.3	90	45	56
Thermalito Forebay, north	11/19/02	1300	Btm	12.2	54.0	7.4	91	51	61
Thermalito Forebay, north	12/12/02	1320	Btm	11.5	52.7	7.5	94	52	56
Thermalito Forebay, north	12/20/02	1320	Btm	11.5	52.7	7.5	94		
Thermalito Forebay, north	01/14/03	0915	Btm	8.8	47.8	7.2	88	44	55
Thermalito Forebay, north	02/26/03	1330	Btm	8.7	47.7	7.3	83	44	52
Thermalito Forebay, north	03/19/03	1000	Btm	9.6	49.3	7.6	76	40	48
Thermalito Forebay, north	04/15/03	1030	Btm	12.1	53.8	7.3	80	40	50
Thermalito Forebay, north	05/20/03	1115	Btm	10.8	51.4	7.3	76	40	47
Thermalito Forebay, north	06/23/03	1115	Btm	13.7	56.7	7.2	59	40	36
Thermalito Forebay, north	07/21/03	1400	Btm	14.4	57.9	7.3	80	41	50
Thermalito Forebay, north	08/25/03	1315	Btm	14.3	57.7	7.2	78	41	49
Thermalito Forebay, north	09/22/03	1245	Btm	11.6	52.9	7.5	68	40	42
Thermalito Forebay, north	10/21/03	1200	Btm	10.5	50.9	7.5	69	38	55
Thermalito Forebay, south	04/02/02	1415	Btm	12.4	54.2	7.8	90	42	59
Thermalito Forebay, south	04/29/02	0730	Btm	10.6	51.1	7.2	91	42	58
Thermalito Forebay, south	05/22/02	0900	Btm	10.9	51.6	7.3	65	40	35
Thermalito Forebay, south	06/17/02	1035	Btm	15.3	59.5	7.4	86	39	56
Thermalito Forebay, south	07/18/02	1130	Btm	13.5	56.3	7.2	90	n/a	58
Thermalito Forebay, south	08/19/02	1300	Btm	14.4	57.9	7.0	89	40	57
Thermalito Forebay, south	09/17/02	1000	Btm	10.5	50.9	7.3	91	n/a	57
Thermalito Forebay, south	10/22/02	0840	Btm	12.8	55.0	7.3	90	45	54
Thermalito Forebay, south	11/19/02	1400	Btm	12.1	53.8	7.4	91	51	60
Thermalito Forebay, south	12/12/02	1215	Btm	11.4	52.5	7.6	94	52	56
Thermalito Forebay, south	01/14/03	1045	Btm	9.1	48.4	7.2	88	44	57
Thermalito Forebay, south	02/26/03	1430	Btm	8.7	47.7	7.5	82	44	54
Thermalito Forebay, south	03/19/03	1055	Btm	10.7	51.3	7.7	76	38	49
Thermalito Forebay, south	04/15/03	1145	Btm	12.5	54.5	7.3	81	40	51
Thermalito Forebay, south	05/20/03	1215	Btm	10.8	51.4	7.2	76	40	50
Thermalito Forebay, south	06/23/03	1245	Btm	14.1	57.4	7.3	63	40	38
Thermalito Forebay, south	07/21/03	1230	Btm	14.5	58.1	7.3	80	41	51
Thermalito Forebay, south	08/25/03	1200	Btm	14.3	57.7	7.3	78	41	50
Thermalito Forebay, south	09/22/03	1200	Btm	11.6	52.9	7.7	70	40	48
Thermalito Forebay, south	10/21/03	1300	Btm	10.6	51.1	7.5	68	35	46

Bold or highlighted results indicate criteria or goal exceeded

Appendix A. Continued.

Station Name	Date	Time (pst)	Depth (m)	Temp (°C)	Temp. (°F)	pH	Specific Conductance (field) µmhos/cm	Alkalinity mg/L CaCO3	TDS mg/L
USEPA Secondary MCL						6.5-8.5			500
California DHS Secondary MCL							900		500
USEPA MCL Goal (Taste & Odor)									500
California DHS Secondary MCL (Taste & Odor)							900		
Water Quality For Agriculture Goal						6.5-8.4	700		450
USEPA Nat. Ambient Water/Instant. Min & Max						6.5-9			
USEPA Nat. Ambient Water/Taste & Odor						5-9			250
CVRWQCB Basin Plan-Feather River							150		
Thermalito Afterbay, north	04/02/02	1635	Btm	14.5	58.1	7.7	90	44	60
Thermalito Afterbay, north	04/24/02	0800	Btm	13.5	56.3	7.8	90	42	46
Thermalito Afterbay, north	05/23/02	0930	Btm	12.6	54.7	7.4	84	39	46
Thermalito Afterbay, north	06/17/02	0900	Btm	16.2	61.2	7.4	87	40	58
Thermalito Afterbay, north	07/18/02	0930	Btm	13.7	56.7	7.2	90	41	48
Thermalito Afterbay, north	08/19/02	0830	Btm	15.2	59.4	7.3	89	41	56
Thermalito Afterbay, north	09/17/02	1200	Btm	11.7	53.1	7.2	92	42	50
Thermalito Afterbay, north	10/22/02	1130	Btm	13.1	55.6	7.4	90	45	59
Thermalito Afterbay, north	11/19/02	1125	Btm	12.0	53.6	7.5	91	51	61
Thermalito Afterbay, north	12/12/02	1015	Btm	11.6	52.9	7.7	94	52	57
Thermalito Afterbay, north	01/14/03	1415	Btm	9.3	48.7	7.3	87	44	55
Thermalito Afterbay, north	02/26/03	1140	Btm	8.9	48.0	7.6	82	44	52
Thermalito Afterbay, north	03/19/03	1330	Btm	12.6	54.7	7.9	80	42	51
Thermalito Afterbay, north	04/15/03	0900	Btm	13.7	56.7	7.3	83	42	51
Thermalito Afterbay, north	05/20/03	0800	Btm	12.4	54.3	7.5	78	41	48
Thermalito Afterbay, north	06/24/03	0940	Btm	16.1	61.0	7.4	87	40	52
Thermalito Afterbay, north	07/21/03	1115	Btm	14.8	58.6	7.4	80	41	50
Thermalito Afterbay, north	08/25/03	1045	Btm	14.7	58.5	7.0	78	41	50
Thermalito Afterbay, north	09/22/03	1030	Btm	12.7	54.9	7.7	71	42	50
Thermalito Afterbay, north	10/21/03	1000	Btm	11.5	52.7	7.6	70	37	53
Thermalito Afterbay, south	04/02/02	1745	Btm	13.9	57.0	7.6	91	44	59
Thermalito Afterbay, south	04/24/02	0930	Btm	15.3	59.5	7.9	90	43	49
Thermalito Afterbay, south	05/23/02	0830	Btm	13.1	55.6	7.4	84	41	44
Thermalito Afterbay, south	06/17/02	0815	Btm	16.4	61.5	7.4	86	39	58
Thermalito Afterbay, south	07/18/02	0800	Btm	14.0	57.2	7.2	90	41	57
Thermalito Afterbay, south	08/19/02	0915	Btm	15.1	59.2	7.3	89	41	55
Thermalito Afterbay, south	09/17/02	1315	Btm	12.3	54.1	7.2	92	42	48
Thermalito Afterbay, south	10/22/02	1215	Btm	13.5	56.3	7.4	90	45	58
Thermalito Afterbay, south	11/19/02	1025	Btm	12.1	53.8	7.6	92	51	57
Thermalito Afterbay, south	12/12/02	0900	Btm	11.6	52.9	7.8	93	52	57
Thermalito Afterbay, south	01/14/03	1330	Btm	9.5	49.1	7.3	87	42	56
Thermalito Afterbay, south	02/26/03	1000	Btm	8.4	47.1	7.6	82	43	51
Thermalito Afterbay, south	03/19/03	1230	Btm	12.8	55.0	7.9	81	43	49
Thermalito Afterbay, south	04/15/03	0800	Btm	14.3	57.7	7.3	84	42	50
Thermalito Afterbay, south	05/20/03	0900	Btm	13.3	55.9	7.5	78	41	50
Thermalito Afterbay, south	06/24/03	0825	Btm	17.6	63.7	7.4	88	41	53
Thermalito Afterbay, south	07/21/03	0935	Btm	14.9	58.8	7.3	78	41	49
Thermalito Afterbay, south	08/25/03	0930	Btm	14.7	58.5	7.3	70	40	46
Thermalito Afterbay, south	09/22/03	0930	Btm	12.9	55.2	7.7	71	42	48
Thermalito Afterbay, south	10/21/03	0900	Btm	11.9	53.4	7.6	70	37	52

Bold or highlighted results indicate criteria or goal exceeded

Appendix B. SPW5 Groundwater quality monitoring well physical data and criteria.

Well	Map Locater	Date	Time (PST)	Temp. (°C)	Temp. (°F)	Specific Conductance (field) µmhos/cm	pH
USEPA Secondary MCL							6.5-8.5
California DHS Secondary MCL						**900**	
California DHS Secondary MCL (Taste & Odor)						**900**	
Water Quality For Agriculture Goal						**700**	6.5-8.4
USEPA Nat. Ambient Water/Instant. Min & Max							6.5-9
USEPA Nat. Ambient Water/Taste & Odor							5-9
CVRWQCB Basin Plan						N/A	
19N02E02 M	R02	07/01/03	1045	20.9	69.6	180	7.5
19N02E02 M	R02	10/15/03	1030	18.8	65.8	208	7.4
18N02E12 M	K12	07/01/03	1150			415	7.3
18N02E12 M	K12	10/15/03	1200			449	7.1
18N02E23 M	B23	07/07/03	1240			685	7.5
18N02E23 M	B23	10/14/03	1305			**714**	7.4
18N02E32H01 M	S32	07/07/03	1120			480	7.5
18N02E32H01 M	S32	10/29/03	1130			541	7.4
18N03E08B03 M	K08	06/11/03	1250	19.7	67.5	167	8.1
18N03E08B03 M	K08	11/04/03	1020	19.3	66.7	204	8.1
18N03E18 M	S18	07/07/03	0920			343	7.3
18N03E18 M	S18	10/15/03	1235			347	7.3
18N03E19 M	A19	07/02/03	1200			341	7.2
18N03E19 M	A19	10/14/03	1210			343	7.3
18N03E19 M	H19	07/07/03	1000			465	7.4
18N03E19 M	H19	10/14/03	1230			501	7.3
18N03E21G01 M	M21	06/11/03	1330	16.8	62.2	324	7.3
18N03E21G01 M	M21	10/29/03	1030	16.7	62.1	368	7.2
19N02E13Q01 M	L13	06/11/03	0915	21.1	70.0	137	8.1
19N02E13Q01 M	L13	10/15/03	0830	20.1	68.2	158	8.2
19N02E15N02 M	R15	06/11/03	1040	18.5	65.3	**755**	7.4
19N02E15N02 M	R15	10/15/03	0915	18.5	65.3	**849**	7.3
19N02E22 M	M22	07/02/03	0800			**783**	7.4
19N02E22 M	M22	10/14/03	1045			**1220**	7.4
19N02E27 M	J27	07/07/03	1430			457	7.5
19N02E27 M	J27	10/14/03	1130			269	7.3
19N02E36 M	J36	07/02/03	0930	19.1	66.4	454	6.9
19N02E36 M	J36	10/29/03	0930	17.9	64.2	414	7.1
19N03E05N02 M	N05	06/11/03	1200	21.0	69.8	153	7.3
19N03E05N02 M	N05	10/14/03	1010	20.6	69.1	168	7.2
19N03E11 M	A11	07/01/03	0900	18.9	66.0	124	7.5
19N03E11 M	A11	10/15/03	1315	15.8	60.4	153	7.3
19N03E17 M	H17	07/01/03	0820			236	7.3
19N03E17 M	H17	10/15/03	1200			261	7.2
19N03E19 M	D19	07/01/03	0750			166	7.5
19N03E19 M	D19	10/14/03	1420	20.6	69.1	192	7.3

Bold or highlighted results indicate criteria or goal exceeded

Appendix C. SPW1 Surface water quality mineral data and criteria.

Station Name	Date	Time (PST)	Water Level	Total Ca (mg/L)	Diss Ca (mg/L)	Diss K (mg/L)	Total Mg (mg/L)	Diss Mg (mg/L)	Diss Na (mg/L)	Diss B (mg/L)	Diss Cl (mg/L)	Diss SO4 (mg/L)	Total Hardness (mg/L CaCO3)	Diss Hardness (mg/L CaCO3)
USEPA Primary MCL												500		
USEPA Secondary MCL											250	250		
USEPA MCL Goal												500		
California DHS Secondary MCL											250	250(a)		
California DHS Action Level for drinking water										1				
Water Quality For Agriculture Goal									69	0.7	106			
Taste and odor (USEPA Drinking Water Advisory)									30-60					
USEPA draft Drinking Water Advisory									20					
USEPA Nat. Ambient Water/Instant. Min & Max														
USEPA Nat. Ambient Water/Taste & Odor														
USEPA Nat. Ambient Water/Aquatic Life Toxicity/4-day average											230			
USEPA Nat. Ambient Water/Aquatic Life Toxicity/Maximum 1 hour											860			
CVRWQCB Basin Plan														
Station Name	**Date**	**Time (PST)**	**Water Level**	**Total Ca (mg/L)**	**Diss Ca (mg/L)**	**Diss K (mg/L)**	**Total Mg (mg/L)**	**Diss Mg (mg/L)**	**Diss Na (mg/L)**	**Diss B (mg/L)**	**Diss Cl (mg/L)**	**Diss SO4 (mg/L)**	**Total Hardness (mg/L CaCO3)**	**Diss Hardness (mg/L CaCO3)**
Thermalito Forebay, north	04/29/02	0845	Btm	9	9	0.7	4	4	3	<0.1	<1	2	39	39
Thermalito Forebay, north	05/22/02	1030	Btm	8	8	0.7	4	4	3	<0.1	<1	2	36	36
Thermalito Forebay, north	06/17/02	1145	Btm	8	8	0.7	4	4	3	<0.1	<1	2	36	36
Thermalito Forebay, north	07/18/02	1300	Btm	9	9	0.9	4	4	4	<0.1	<1	2	39	39
Thermalito Forebay, north	08/19/02	1100	Btm	9	9	0.8	4	4	4	<0.1	1	2	39	39
Thermalito Forebay, north	09/17/02	0800	Btm	9	8	0.7	4	4	3	<0.1	1	2	39	36
Thermalito Forebay, north	10/22/02	0930	Btm	9	9	0.9	4	4	4	<0.1	1	2	39	39
Thermalito Forebay, north	11/19/02	1300	Btm	9	8	0.9	4	4	4	<0.1	1	2	39	36
Thermalito Forebay, north	01/14/03	0915	Btm	9	9	0.9	4	4	4	<0.1	<1	2	39	39
Thermalito Forebay, north	02/26/03	1330	Btm	9	8	0.8	4	4	3	<0.1	1	2	39	36
Thermalito Forebay, north	03/19/03	1000	Btm	8	8	0.7	4	4	3	<0.1	1	2	36	36
Thermalito Forebay, north	04/15/03	1030	Btm	8	8	0.7	4	3	3	<0.1	1	2	36	32
Thermalito Forebay, north	05/20/03	1115	Btm	8	8	0.7	4	4	3	<0.1	1	2	36	36
Thermalito Forebay, north	06/23/03	1115	Btm	7	7	0.6	3	3	3	<0.1	<1	2	30	30
Thermalito Forebay, north	07/21/03	1400	Btm	7	8	0.7	3	4	3	<0.1	1	2	30	36
Thermalito Forebay, north	08/25/03	1315	Btm	8	8	0.8	4	4	3	<0.1	<1	2	36	36
Thermalito Forebay, north	09/22/03	1245	Btm	7	7	0.6	3	3	3	<0.1	<1	2	30	30
Thermalito Forebay, north	10/21/03	1200	Btm	7	7	0.6	3	3	3	<0.1	<1	2	30	30

Bold or highlighted results indicate criteria or goal exceeded

a. 500 mg/L Upper Limit

Appendix C. Continued.

USEPA Primary MCL												500		
USEPA Secondary MCL											250	250		
USEPA MCL Goal												500		
California DHS Secondary MCL											250	250(a)		
California DHS Action Level for drinking water										1				
Water Quality For Agriculture Goal									69	0.7	106			
Taste and odor (USEPA Drinking Water Advisory)									30-60					
USEPA draft Drinking Water Advisory									20					
USEPA Nat. Ambient Water/Instant. Min & Max														
USEPA Nat. Ambient Water/Taste & Odor														
USEPA Nat. Ambient Water/Aquatic Life Toxicity/4-day average											230			
USEPA Nat. Ambient Water/Aquatic Life Toxicity/Maximum 1 hour											860			
Station Name	**Date**	**Time (PST)**	**Water Level**	**Total Ca (mg/L)**	**Diss Ca (mg/L)**	**Diss K (mg/L)**	**Total Mg (mg/L)**	**Diss Mg (mg/L)**	**Diss Na (mg/L)**	**Diss B (mg/L)**	**Diss Cl (mg/L)**	**Diss SO4 (mg/L)**	**Total Hardness (mg/L CaCO3)**	**Diss Hardness (mg/L CaCO3)**
CVRWQCB Basin Plan														
Thermalito Forebay, south	04/29/02	0730	Btm	9	9	0.8	4	4	3	<0.1	<1	2	39	39
Thermalito Forebay, south	05/22/02	0900	Btm	9	9	0.8	4	4	4	<0.1	<1	2	39	39
Thermalito Forebay, south	06/17/02	1035	Btm	9	8	0.7	4	4	3	<0.1	<1	2	39	36
Thermalito Forebay, south	07/18/02	1130	Btm	9	9	0.8	4	4	4	<0.1	<1	2	39	39
Thermalito Forebay, south	08/19/02	1300	Btm	10	9	0.9	4	4	4	<0.1	1	2	41	39
Thermalito Forebay, south	09/17/02	1000	Btm	8	8	0.7	4	4	3	<0.1	1	2	36	36
Thermalito Forebay, south	10/22/02	0840	Btm	9	9	0.9	4	4	4	<0.1	1	2	39	39
Thermalito Forebay, south	11/19/02	1400	Btm	9	8	0.9	4	4	4	<0.1	1	2	39	36
Thermalito Forebay, south	01/14/03	1045	Btm	8	9	0.9	4	4	4	<0.1	<1	2	36	39
Thermalito Forebay, south	02/26/03	1430	Btm	8	8	0.8	4	4	3	<0.1	1	2	36	36
Thermalito Forebay, south	03/19/03	1055	Btm	8	8	0.8	4	3	3	<0.1	1	2	36	32
Thermalito Forebay, south	04/15/03	1145	Btm	8	8	0.7	4	4	3	<0.1	1	2	36	36
Thermalito Forebay, south	05/20/03	1215	Btm	8	8	0.7	4	4	3	<0.1	1	2	36	36
Thermalito Forebay, south	06/23/03	1245	Btm	8	7	0.6	4	3	3	<0.1	<1	2	36	30
Thermalito Forebay, south	07/21/03	1230	Btm	8	8	0.8	4	4	3	<0.1	<1	2	36	36
Thermalito Forebay, south	08/25/03	1200	Btm	8	8	0.8	4	4	3	<0.1	<1	2	36	36
Thermalito Forebay, south	09/22/03	1200	Btm	7	7	0.6	3	3	3	<0.1	<1	2	30	30
Thermalito Forebay, south	10/21/03	1300	Btm	7	7	0.6	3	3	3	<0.1	<1	2	30	30

Bold or highlighted results indicate criteria or goal exceeded

a. 500 mg/L Upper Limit

Appendix C. Continued.

Station Name	Date	Time (PST)	Water Level	Total Ca (mg/L)	Diss Ca (mg/L)	Diss K (mg/L)	Total Mg (mg/L)	Diss Mg (mg/L)	Diss Na (mg/L)	Diss B (mg/L)	Diss Cl (mg/L)	Diss SO4 (mg/L)	Total Hardness (mg/L CaCO3)	Diss Hardness (mg/L CaCO3)
USEPA Primary MCL												500		
USEPA Secondary MCL											250	250		
USEPA MCL Goal												500		
California DHS Secondary MCL											250	250(a)		
California DHS Action Level for drinking water										1				
Water Quality For Agriculture Goal									69	0.7	106			
Taste and odor (USEPA Drinking Water Advisory)									30-60					
USEPA draft Drinking Water Advisory									20					
USEPA Nat. Ambient Water/Instant. Min & Max														
USEPA Nat. Ambient Water/Taste & Odor														
USEPA Nat. Ambient Water/Aquatic Life Toxicity/4-day average											230			
USEPA Nat. Ambient Water/Aquatic Life Toxicity/Maximum 1 hour											860			
CVRWQCB Basin Plan														
Thermalito Afterbay, north	04/24/02	0800	Btm	9	9	0.8	4	4	3	<0.1	<1	2	39	39
Thermalito Afterbay, north	05/23/02	0930	Btm	8	8	0.8	4	4	3	<0.1	< 1	2	36	36
Thermalito Afterbay, north	06/17/02	0900	Btm	8	8	0.7	4	4	3	<0.1	< 1	2	36	36
Thermalito Afterbay, north	07/18/02	0930	Btm	9	9	0.9	4	4	3	<0.1	< 1	2	39	39
Thermalito Afterbay, north	08/19/02	0830	Btm	10	10	0.9	4	4	4	<0.1	1	2	41	41
Thermalito Afterbay, north	09/17/02	1200	Btm	8	8	0.7	4	4	4	<0.1	1	2	36	36
Thermalito Afterbay, north	10/22/02	1130	Btm	9	9	0.9	4	4	4	<0.1	1	2	39	39
Thermalito Afterbay, north	11/19/02	1125	Btm	9	8	0.9	4	4	4	<0.1	1	2	39	36
Thermalito Afterbay, north	01/14/03	1415	Btm	9	8	0.9	4	4	4	<0.1	<1	2	39	36
Thermalito Afterbay, north	02/26/03	1140	Btm	8	8	0.8	4	4	3	<0.1	1	2	36	36
Thermalito Afterbay, north	03/19/03	1330	Btm	8	8	0.8	4	4	4	<0.1	1	2	36	36
Thermalito Afterbay, north	04/15/03	0900	Btm	8	8	0.8	4	4	3	<0.1	1	2	36	36
Thermalito Afterbay, north	05/20/03	0800	Btm	8	8	0.7	4	3	3	<0.1	1	2	36	32
Thermalito Afterbay, north	06/23/03	0940	Btm	8	7	0.6	3	3	3	<0.1	<1	2	32	30
Thermalito Afterbay, north	07/21/03	1115	Btm	7	7	0.7	3	3	3	<0.1	1	2	30	30
Thermalito Afterbay, north	08/25/03	1045	Btm	8	8	0.8	4	4	3	<0.1	<1	2	36	36
Thermalito Afterbay, north	09/22/03	1030	Btm	8	7	0.7	3	3	3	<0.1	<1	2	32	30
Thermalito Afterbay, north	10/21/03	1000	Btm	7	7	0.6	3	3	3	<0.1	1	2	30	30

Bold or highlighted results indicate criteria or goal exceeded

a. 500 mg/L Upper Limit

Appendix C. Continued.

Station Name	Date	Time (PST)	Water Level	Total Ca (mg/L)	Diss Ca (mg/L)	Diss K (mg/L)	Total Mg (mg/L)	Diss Mg (mg/L)	Diss Na (mg/L)	Diss B (mg/L)	Diss Cl (mg/L)	Diss SO4 (mg/L)	Total Hardness (mg/L CaCO3)	Diss Hardness (mg/L CaCO3)
USEPA Primary MCL												500		
USEPA Secondary MCL											250	250		
USEPA MCL Goal												500		
California DHS Secondary MCL											250	250(a)		
California DHS Action Level for drinking water										1				
Water Quality For Agriculture Goal									69	0.7	106			
Taste and odor (USEPA Drinking Water Advisory)									30-60					
USEPA draft Drinking Water Advisory									20					
USEPA Nat. Ambient Water/Instant. Min & Max														
USEPA Nat. Ambient Water/Taste & Odor														
USEPA Nat. Ambient Water/Aquatic Life Toxicity/4-day average											230			
USEPA Nat. Ambient Water/Aquatic Life Toxicity/Maximum 1 hour											860			
CVRWQCB Basin Plan														
Thermalito Afterbay, south	04/24/02	0930	Btm	9	9	0.7	4	4	3	<0.1	<1	2	39	39
Thermalito Afterbay, south	05/23/02	0830	Btm	8	8	0.7	4	4	3	<0.1	< 1	2	36	36
Thermalito Afterbay, south	06/17/02	0815	Btm	9	8	0.7	4	3	3	<0.1	< 1	2	39	32
Thermalito Afterbay, south	07/18/02	0800	Btm	9	9	0.8	4	4	4	<0.1	< 1	2	39	39
Thermalito Afterbay, south	08/19/02	0915	Btm	8	10	0.9	3	4	4	<0.1	1	2	32	41
Thermalito Afterbay, south	09/17/02	1315	Btm	8	8	0.7	4	4	3	<0.1	1	2	38	36
Thermalito Afterbay, south	10/22/02	1200	Btm	9	9	0.9	4	4	4	<0.1	1	2	39	39
Thermalito Afterbay, south	11/19/02	1025	Btm	9	9	1.0	4	4	4	<0.1	1	2	39	39
Thermalito Afterbay, south	01/14/03	1330	Btm	8	8	0.9	4	4	4	<0.1	<1	2	38	36
Thermalito Afterbay, south	02/26/03	1000	Btm	8	8	0.8	4	4	3	<0.1	1	2	36	36
Thermalito Afterbay, south	03/19/03	1230	Btm	8	8	0.8	4	4	4	<0.1	1	2	38	36
Thermalito Afterbay, south	04/15/03	0800	Btm	8	8	0.8	4	4	3	<0.1	1	2	36	36
Thermalito Afterbay, south	05/20/03	0900	Btm	8	8	0.7	4	4	3	<0.1	1	2	36	36
Thermalito Afterbay, south	06/24/03	0825	Btm	8	8	0.7	4	3	3	<0.1	<1	2	38	32
Thermalito Afterbay, south	07/21/03	0935	Btm	8	8	0.7	3	3	3	<0.1	1	2	32	32
Thermalito Afterbay, south	08/25/03	0930	Btm	8	8	0.7	4	4	3	<0.1	<1	2	36	36
Thermalito Afterbay, south	09/22/03	0930	Btm	8	8	0.7	4	4	3	<0.1	<1	2	38	36
Thermalito Afterbay, south	10/21/03	0900	Btm	7	7	0.6	3	3	3	<0.1	<1	2	30	30

Bold or highlighted results indicate criteria or goal exceeded

a. 500 mg/L Upper Limit

Appendix D. SPW5 Groundwater quality monitoring well mineral data and criteria.

Well	Map Locater	Date	Time (PST)	Total Ca mg/L	Diss. Ca mg/L	Diss. K mg/L	Total Mg	Diss. Mg mg/L	Diss. Na mg/L	Diss. B mg/L	Diss. Cl mg/L	Diss. SO4 mg/L	Total Alkalinity mg/L CaCO3	TDS mg/L	Total Hardness mg/L CaCO3	Diss. Hardness mg/L CaCO3
USEPA Primary MCL												500				
USEPA Secondary MCL											250	250		**500**		
USEPA Secondary MCL														**500**		
USEPA MCL Goal (Taste & Odor)												500		**500**		
California DHS Secondary MCL											250	250(a)				
California DHS Action Level for drinking water										1						
Water Quality For Agriculture Goal									**69**	0.7	106			**450**		
Taste and odor (USEPA Drinking Water Advisory)									**30-60**							
USEPA draft Drinking Water Advisory									**20**							
USEPA Nat. Ambient Water/Instant. Min & Max																
USEPA Nat. Ambient Water/Taste & Odor																
USEPA Nat. Ambient Water/Aquatic Life											230					
USEPA Nat. Ambient Water/Aquatic Life											860					
CVRWQCB Basin Plan																
19N02E02 M	R02	7/1/2003	1045	11	11	1.2	10	10	11	<0.1	5	4	85	114	69	69
19N02E02 M	R02	10/15/2003	1030	11	10	1.2	9	9	11	<0.1	4	3	79	151	65	62
18N02E12 M	K12	7/1/2003	1150	30	29	0.8	27	26	17	<0.1	4	18	204	273	186	180
18N02E12 M	K12	10/15/2003	1200	33	33	0.8	28	27	19	<0.1	4	24	211	294	198	194
18N02E23 M	B23	7/7/2003	1240	53	52	1.2	47	46	**22**	<0.1	3	26	366	416	326	319
18N02E23 M	B23	10/14/2003	1305	52	52	1.1	48	47	**24**	<0.1	3	26	363	417	328	323
18N02E32H01 M	S32	7/7/2003	1120	33	32	2.4	33	32	19	<0.1	5	5	262	303	218	212
18N02E32H01 M	S32	10/29/2003	1130	41	41	2.8	42	42	16	<0.1	4	7	291	330	275	275
18N03E08B03 M	K08	6/11/2003	1250	12	12	2.6	10	10	13	<0.1	3	3	100	106	71	71
18N03E08B03 M	K08	11/4/2003	1020	12	12	2.5	10	10	14	0.1	2	4	100	133	71	71
18N03E18 M	S18	7/7/2003	0920	22	21	1.6	22	21	12	<0.1	16	6	154	227	146	139
18N03E18 M	S18	10/15/2003	1235	21	21	1.6	23	22	13	<0.1	16	6	148	220	147	143
18N03E19 M	A19	7/2/2003	1200	23	22	1.9	24	23	14	<0.1	6	6	166	221	156	150
18N03E19 M	A19	10/14/2003	1210	21	22	1.9	23	23	14	<0.1	6	5	162	218	147	150
18N03E19 M	H19	7/7/2003	1000	35	35	0.5	31	32	11	<0.1	11	7	235	299	215	219
18N03E19 M	H19	10/14/2003	1230	35	34	<0.5	33	32	12	<0.1	12	8	231	305	223	217
18N03E21G01 M	M21	6/11/2003	1330	32	30	1.3	28	27	8	<0.1	7	20	163	210	195	186
18N03E21G01 M	M21	10/29/2003	1030	29	28	1.3	26	25	7	<0.1	6	21	152	225	180	173
19N02E13G01 M	L13	6/11/2003	0915	10	10	1.7	8	8	9	<0.1	3	<1	80	89	58	58
19N02E13G01 M	L13	10/15/2003	0830	10	10	1.8	8	8	9	<0.1	3	1	77	125	58	58
19N02E15N02 M	R15	6/11/2003	1040	78	76	1.7	52	51	**48**	<0.1	15	48	432	**491**	409	400
19N02E15N02 M	R15	10/15/2003	0915	68	66	1.7	47	45	**44**	<0.1	17	44	405	**479**	363	350
19N02E22 M	M22	7/2/2003	0800	90	72	1.4	56	46	**28**	<0.1	15	61	362	**490**	455	369
19N02E22 M	M22	10/14/2003	1045	125	127	1.3	72	71	**30**	<0.1	29	195	437	**801**	609	610
19N02E27 M	J27	7/7/2003	1430	36	36	1.1	23	23	18	<0.1	25	17	193	300	185	185
19N02E27 M	J27	10/14/2003	1130	20	20	1	14	14	12	<0.1	12	5	113	192	108	108
19N02E36 M	J36	7/2/2003	0930	34	34	1.3	31	31	**21**	<0.1	8	17	234	309	213	213
19N02E36 M	J36	10/29/2003	0930	31	30	1.2	27	26	19	<0.1	6	13	207	268	189	182
19N03E05N02 M	N05	6/11/2003	1200	11	11	0.8	8	8	11	<0.1	7	2	64	101	60	60
19N03E05N02 M	N05	10/14/2003	1010	11	10	0.9	8	8	11	<0.1	8	2	65	107	60	58
19N03E11 M	A11	7/1/2003	0900	8	7	0.6	4	4	5	<0.1	2	6	44	75	36	34
19N03E11 M	A11	10/15/2003	1315	6	7	<0.5	9	9	11	<0.1	2	1	76	109	52	56
19N03E17 M	H17	7/1/2003	0820	13	14	1.7	13	14	16	<0.1	9	9	93	151	86	93
19N03E17 M	H17	10/15/2003	1200	14	13	1.5	14	13	15	<0.1	9	9	90	200	93	86
19N03E19 M	D19	7/1/2003	0750	9	10	1.3	8	9	12	<0.1	3	3	84	101	55	62
19N03E19 M	D19	10/14/2003	1420	10	10	1.3	9	9	12	<0.1	3	2	81	151	62	62

Bold or highlighted results indicate criteria or goal exceeded

a. 500 mg/L Upper Limit

Appendix E. SPW1 Surface water quality metal data and criteria.

USEPA Primary MCL and MCL Goal				1000		2
USEPA Secondary MCL				**50-200**		
California DHS Primary MCL				1000		2
California DHS Secondary MCL				**200**		
California Secondary MCL (Taste & Odor)				**200**		
Water Quality for Agriculture Goal				5000		
California Public Health Goal for Drinking Water				600		1.2
Calif. Toxics Rule Criteria (USEPA) For Drinking Water Sources						0.05
USEPA Nat. Recomm. W Q Criteria / 4-day avg (total) (a)				**87**		
USEPA Nat. Recomm. W Q Criteria / 1-hour avg (total) (a)				750		
USEPA National Ambient W Q Criteria / 4-day avg						0.77
USEPA National Ambient W Q Criteria / 1-hour average						1.4
Station Name	**Level**	**Date**	**Time (PST)**	**Total Al µg/L**	**Diss. Al µg/L**	**Total Hg µg/L**
Thermalito Forebay, north	Btm	4/2/2002	1215	41.1	6.6	0.00061
Thermalito Forebay, north	Btm	4/29/2002	0845	**104**	6	0.00118
Thermalito Forebay, north	Btm	5/22/2002	1030	32.4	2.18	0.00063
Thermalito Forebay, north	Btm	6/17/2002	1145	27.4	27.7	0.00076
Thermalito Forebay, north	Btm	7/18/2002	1300	27.4	7.2	0.00039
Thermalito Forebay, north	Btm	8/19/2002	1100	32.9	2.2	0.00036
Thermalito Forebay, north	Btm	9/17/2002	0800	38.8	1.6	0.00039
Thermalito Forebay, north	Btm	10/22/2002	0950	**53.3**	5.2	0.00026
Thermalito Forebay, north	Btm	11/19/2002	1300	**117**	9.6	0.00132
Thermalito Forebay, north	Btm	12/12/2002	1320	**76.3**	8.9	0.00065
Thermalito Forebay, north	Btm	1/14/2003	0915	**167**	19.4	0.00191
Thermalito Forebay, north	Btm	2/26/2003	1330	**77.7**	20.2	0.00085
Thermalito Forebay, north	Btm	3/19/2003	1000	**74.4**	8.1	0.00136
Thermalito Forebay, north	Btm	4/15/2003	1030	**55.6**	10.5	0.0007
Thermalito Forebay, north	Btm	5/20/2003	1115	34.8	12.9	0.00106
Thermalito Forebay, north	Btm	6/23/2003	1115	22.4	18.3	0.00075
Thermalito Forebay, north	Btm	7/21/2003	1400	17.1	9.72	0.000597
Thermalito Forebay, north	Btm	8/25/2003	1315	11	9.46	0.00044
Thermalito Forebay, north	Btm	9/22/2003	1245	18.3	15.9	0.00065
Thermalito Forebay, north	Btm	10/21/2003	1200	18	10.2	0.00075
Thermalito Forebay, south	Btm	4/2/2002	1415	46.6	5.5	0.00097
Thermalito Forebay, south	Btm	4/29/2002	0730	**50**	6.5	0.00077
Thermalito Forebay, south	Btm	5/22/2002	0900	30.5	2.9	0.00067
Thermalito Forebay, south	Btm	6/17/2002	1035	**118**	2.2	0.00073
Thermalito Forebay, south	Btm	7/18/2002	1130	38.7	7	0.00039
Thermalito Forebay, south	Btm	8/19/2002	1300	32.6	2.2	0.00031
Thermalito Forebay, south	Btm	9/17/2002	1000	34.1	3.2	0.00038
Thermalito Forebay, south	Btm	10/22/2002	0840	46	4.2	0.00024
Thermalito Forebay, south	Btm	11/19/2002	1400	**111**	7.4	0.001
Thermalito Forebay, south	Btm	12/12/2002	1215	**76.2**	8.9	0.00053
Thermalito Forebay, south	Btm	1/14/2003	1045	**157**	17	0.00168
Thermalito Forebay, south	Btm	2/26/2003	1430	**76.6**	20	0.00085
Thermalito Forebay, south	Btm	3/19/2003	1050	**87.7**	6.9	0.00087
Thermalito Forebay, south	Btm	4/15/2003	1145	**59.4**	9	0.00059
Thermalito Forebay, south	Btm	5/20/2003	1215	38.9	13.1	0.00086
Thermalito Forebay, south	Btm	6/23/2003	1200	19.6	11.5	0.00097
Thermalito Forebay, south	Btm	7/21/2003	1230	30	9.02	0.000558
Thermalito Forebay, south	Btm	8/25/2003	1200	**450**	27.9	0.00144
Thermalito Forebay, south	Btm	9/22/2003	1200	14.5	13.9	0.000971
Thermalito Forebay, south	Btm	10/21/2003	1300	21.4	19	0.00055

Bold or highlighted results indicate criteria or goal exceeded

a. USEPA, Region 9, has allowed acid soluble to account for suspended clay particles in receiving waters.

Appendix E. Continued.

Criteria				Total Al µg/L	Diss. Al µg/L	Total Hg µg/L
USEPA Primary MCL and MCL Goal				1000		2
USEPA Secondary MCL				**50-200**		
California DHS Primary MCL				1000		2
California DHS Secondary MCL				**200**		
California Secondary MCL (Taste & Odor)				**200**		
Water Quality for Agriculture Goal				5000		
California Public Health Goal for Drinking Water				600		1.2
Calif. Toxics Rule Criteria (USEPA) For Drinking Water Sources						0.05
USEPA Nat. Recomm. W Q Criteria / 4-day avg (total) (a)				**87**		
USEPA Nat. Recomm. W Q Criteria / 1-hour avg (total) (a)				750		
USEPA National Ambient W Q Criteria / 4-day avg						0.77
USEPA National Ambient W Q Criteria / 1-hour average						1.4
Station Name	**Level**	**Date**	**Time (PST)**	**Total Al µg/L**	**Diss. Al µg/L**	**Total Hg µg/L**
Thermalito Afterbay, north	Btm	4/2/2002	1635	**113**	22.5	0.00096
Thermalito Afterbay, north	Btm	4/24/2002	0800	46.2	9.2	0.00087
Thermalito Afterbay, north	Btm	5/24/2002	0930	24.2	4.3	0.00053
Thermalito Afterbay, north	Btm	6/17/2002	0900	18.4	<1.5	0.00085
Thermalito Afterbay, north	Btm	7/18/2002	0930	**165**	3.7	0.00068
Thermalito Afterbay, north	Btm	8/19/2002	0830	43.2	2.4	0.00036
Thermalito Afterbay, north	Btm	9/17/2002	1200	32.5	2.3	0.00037
Thermalito Afterbay, north	Btm	10/22/2002	1130	**249**	1.6	0.00033
Thermalito Afterbay, north	Btm	11/19/2002	1125	**113**	5.4	0.00148
Thermalito Afterbay, north	Btm	12/12/2002	1015	**56.3**	7.5	0.00268
Thermalito Afterbay, north	Btm	1/14/2003	1415	**154**	17.1	0.00129
Thermalito Afterbay, north	Btm	2/26/2003	1140	**80.3**	21.8	0.0008
Thermalito Afterbay, north	Btm	3/19/2003	1330	**64.3**	7.4	0.00078
Thermalito Afterbay, north	Btm	4/15/2003	0900	**73.9**	22	0.0007
Thermalito Afterbay, north	Btm	5/20/2003	0800	36.3	9.2	0.00075
Thermalito Afterbay, north	Btm	6/24/2003	0940	15.8	10.6	0.00081
Thermalito Afterbay, north	Btm	7/21/2003	1115	30.8	9.21	0.000558
Thermalito Afterbay, north	Btm	8/25/2003	1045	17.2	10.8	0.00049
Thermalito Afterbay, north	Btm	9/22/2003	1030	**460**	28.2	0.00104
Thermalito Afterbay, north	Btm	10/21/2003	1000	30.3	19.5	0.0005
Thermalito Afterbay, south	Btm	4/2/2002	1745	**120**	28.3	0.00091
Thermalito Afterbay, south	Btm	4/24/2002	0930	**83**	16.1	0.0366
Thermalito Afterbay, south	Btm	5/24/2002	0830	30.1	4	0.00082
Thermalito Afterbay, south	Btm	6/17/2002	0815	30.9	2.1	0.00051
Thermalito Afterbay, south	Btm	7/18/2002	0800	39.5	3.9	0.00047
Thermalito Afterbay, south	Btm	8/19/2002	0915	**80.8**	2.1	0.00068
Thermalito Afterbay, south	Btm	9/17/2002	1315	37.8	2.1	0.00048
Thermalito Afterbay, south	Btm	10/22/2002	1215	36	2	0.00024
Thermalito Afterbay, south	Btm	11/19/2002	1025	**109**	12.3	0.00058
Thermalito Afterbay, south	Btm	12/12/2002	0900	**479**	15.6	0.00062
Thermalito Afterbay, south	Btm	1/14/2003	1330	**152**	19.4	0.00144
Thermalito Afterbay, south	Btm	2/26/2003	1000	**77.9**	19.5	0.00081
Thermalito Afterbay, south	Btm	3/19/2003	1230	**85.7**	8.4	0.00079
Thermalito Afterbay, south	Btm	4/15/2003	0800	**73**	13.2	0.00068
Thermalito Afterbay, south	Btm	5/20/2003	0900	43.8	38.4	0.00076
Thermalito Afterbay, south	Btm	6/24/2003	0825	17.1	11.3	0.00099
Thermalito Afterbay, south	Btm	7/21/2003	0935	21.7	9.31	0.000525
Thermalito Afterbay, south	Btm	8/25/2003	0930	13.8	11.9	0.00046
Thermalito Afterbay, south	Btm	9/22/2003	0930	26.4	22.5	0.00107
Thermalito Afterbay, south	Btm	10/21/2003	0900	32.5	19.3	0.00054

Bold or highlighted results indicate criteria or goal exceeded

a. USEPA, Region 9, has allowed acid soluble to account for suspended clay particles in receiving waters.

Appendix F. SPW5 Groundwater quality monitoring well metal data and criteria.

USEPA Primary MCL and MCL Goal				1000		2
USEPA Secondary MCL				**50-200**	50-200	
California DHS Primary MCL				1000		2
California DHS Secondary MCL				**200**		
California Secondary MCL (Taste & Odor)				**200**		
Water Quality for Agriculture Goal				5000		
California Public Health Goal for Drinking Water				600		1.2
Calif. Toxics Rule Criteria (USEPA) For Drinking Water Sources						0.05
USEPA Nat. Recomm. W Q Criteria / 4-day avg (total) (a)				**87**		
USEPA Nat. Recomm. W Q Criteria / 1-hour avg (total) (a)				750		
USEPA National Ambient W Q Criteria / 4-day avg						0.77
USEPA National Ambient W Q Criteria / 1-hour average						1.4
Well	**Map Locater**	**Time Date**	**(PST)**	**Total Al µg/L**	**Diss. Al µg/L**	**Total Hg µg/L**
19N02E02 M	R02	07/01/03	1045	1.43	1.02	<0.00015
19N02E02 M	R02	10/15/03	1030	2.2	1.19	<0.00015
18N02E12 M	K12	07/01/03	1150	2.15	1.66	0.00029
18N02E12 M	K12	10/15/03	1200	2.11	1.16	0.00038
18N02E23 M	B23	07/07/03	1240	1.08	0.64	0.0008
18N02E23 M	B23	10/14/03	1305	1.41	0.74	0.00084
18N02E32H01 M	S32	07/07/03	1120	1.57	1.4	0.00069
18N02E32H01 M	S32	10/29/03	1130	1.96	1.7	0.00102
19N03E08B03 M	K08	06/11/03	1250	3.23	2.4	<0.00015
18N03E08B03 M	K08	11/04/03	1020	4.42	4.63	<0.00015
18N03E18 M	S18	07/07/03	0920	1.67	1.01	0.00024
18N03E18 M	S18	10/15/03	1235	1.51	0.87	0.00018
18N03E19 M	A19	07/02/03	1200	1.36	0.86	0.00022
18N03E19 M	A19	10/14/03	1210	1.69	1.04	0.00022
18N03E19 M	H19	07/07/03	1000	1.6	0.88	0.00037
18N03E19 M	H19	10/14/03	1230	3.05	0.73	0.00056
18N03E21G01 M	M21	06/11/03	1330	1.32	0.69	<0.00015
18N03E21G01 M	M21	10/29/03	1030	1.93	1.63	<0.00015
19N02E13Q01 M	L13	06/11/03	0915	26.3	2.8	0.00047
19N02E13Q01 M	L13	10/15/03	0830	6.95	2.26	0.00046
19N02E15N02 M	R15	06/11/03	1040	2.12	0.52	0.001
19N02E15N02 M	R15	10/15/03	0945	2.95	0.7	0.00156
19N02E22 M	M22	07/02/03	0800	33.3	2.56	0.00046
19N02E22 M	M22	10/14/03	1045	14.2	9.97	0.00069
19N02E27 M	J27	07/07/03	1430	1.64	1.13	0.00046
19N02E27 M	J27	10/14/03	1130	1.55	0.95	<0.00015
19N02E36 M	J36	07/02/03	0930	2.78	0.76	0.00084
19N02E36 M	J36	10/29/03	0930	27.1	5.4	0.00097
19N03E05N02 M	N05	06/11/03	1200	1.35	0.79	<0.00015
19N03E05N02 M	N05	10/14/03	1010	2.07	1.04	<0.00015
19N03E11 M	A11	07/01/03	0900	**54.8**	**54.9**	0.00033
19N03E11 M	A11	10/15/03	1315	1.93	1.31	0.00063
19N03E17 M	H17	07/01/03	0820	1.91	1.36	0.00035
19N03E17 M	H17	10/15/03	1200	2.14	1.62	0.00038
19N03E19 M	D19	07/01/03	0750	1.81	1.31	0.0006
19N03E19 M	D19	10/14/03	1420	2.14	1.57	0.0006

Bold or highlighted results indicate criteria or goal exceeded

a. USEPA, Region 9, has allowed acid soluble to account for suspended clay particles in receiving waters.